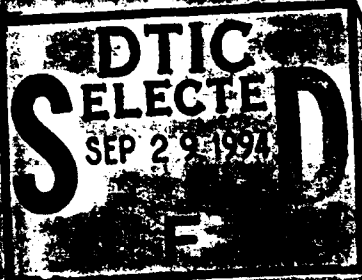
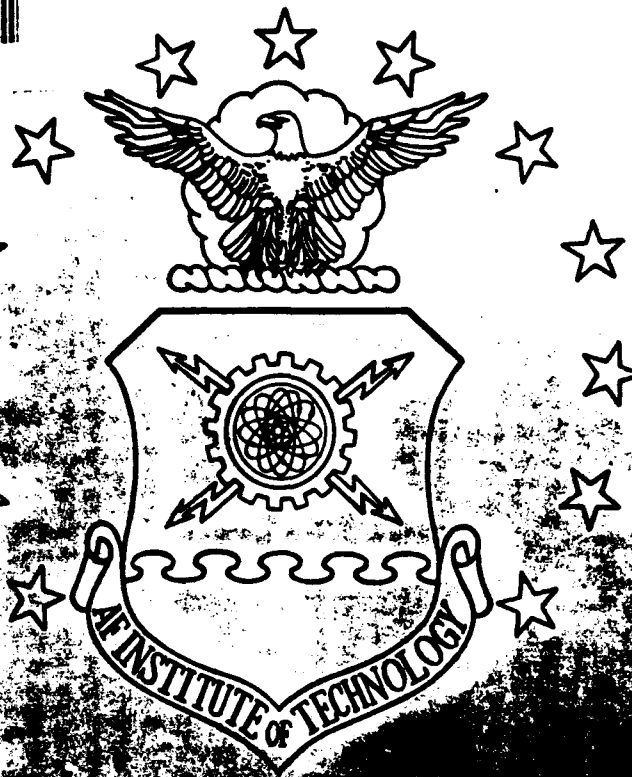


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**COST MANAGEMENT COMPETENCIES
FOR DEPARTMENT OF DEFENSE
PROGRAM MANAGERS**

THESIS

**Brent R. Baxter, B.S. Captain, USAF
Kurt R. Bolin, B.S. Captain, USAF**

AFIT/GSM/LAS/94S-2

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Wright-Patterson Air Force Base, Ohio

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**COST MANAGEMENT COMPETENCIES
FOR DEPARTMENT OF DEFENSE PROGRAM MANAGERS**

THESIS

**Presented to the Faculty of the Graduate School of Logistics and Acquisition Management
of the Air Force Institute of Technology**

Air University

**In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Systems Management**

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September 1994

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Brent R. Baxter
Kurt R. Bolin

Table of Contents

	Page
Acknowledgments	ii
List of Figures	vi
List of Tables	vii
Abstract	x
I. Introduction	1
Background	1
Problem Statement	10
Research Questions	10
Scope	11
Key Terms	11
Summary	13
II. Literature Review	15
Overview	15
The Nature of DoD Program Management	15
Private Sector Research	17
Levinson	17
Kerzner	18
Thornberry and Others	20
Project Management Institute	20
Einsiedel	22
Posner	22
Cadbury-Schweppes	24
Sargent and Stupak	25
Williams and Currey	25
Pettersen	27
Thamhain	28
Kanungo and Misra	30
Government Research	31
Smythe and McMullan	31
Gadeken	32
Best and Kobylarz	33
Acquisition Management Functional Board	35
Summary	36

	Page
III. Methodology	38
Overview	38
Model Development.....	38
Model Structure.....	39
Model Elements	39
Sampling Approach.....	42
Population	42
Target Sample.....	43
Sample.....	44
Instrument Development	48
Frequency and Importance	49
Response Scales.....	49
Pre-Test Instrument Structure	51
Pre-Test.....	51
Survey Methods.....	53
Validity	55
Reliability.....	59
Data Analysis	60
Approach.....	60
Response Data Structure.....	61
Research Question 1 Analysis.....	62
Research Question 2 Analysis.....	62
Summary.....	64
IV. Findings and Analysis	65
Introduction	65
Research Question 1.....	65
Frequency	65
Importance	67
Decision Rule.....	69
Don't Know.....	71
Model Categories.....	71
Comprehension vs. Application	72
Research Question 2.....	73
Results Overview	73
Management Education.....	76
Organization Type	77
Primary Program Activity.....	80
Position Certification Level.....	82
Omitted Competencies	84
Conclusion	86

	Page
V. Conclusions and Recommendations	87
Introduction	87
Results	88
Conclusions.....	89
Education and Training	89
Classification of Program Managers	92
Certification Programs	93
Recommendations	93
Follow-On Research.....	95
Modifying the Model	95
Broader Population.....	97
Cost Analysts and Financial Managers.....	98
Other Skill Areas	99
Competency and Training	99
Appendix A: Survey Instruments	102
Appendix B: Response Summary.....	115
Appendix C: Ranked Data	117
Appendix D: Decision Rule Application to Total Sample	118
Appendix E: Don't Know Percentages.....	119
Appendix F: Kruskal-Wallis Results.....	120
Appendix G: Competency Ranking for Group Comparison	124
Bibliography	128
Vitae	134

List of Figures

	Page
1. Contribution of Skill Development Methods	30
2. Number of Respondents by Instrument Version	45
3. Percentage of Respondents by Organization Type.....	46
4. Percentage of Respondents by Management Education	46
5. Percentage of Respondents by Primary Program Activity	47
6. Number of Respondents by Position Certification Level	48
7. Valuable Competencies by Model Category	72
8. Level of Learning Required for Valuable Competencies	73
9. Number of Kruskal-Wallis Rejections	74
10. Application vs. Comprehension Competencies by Position Level.....	83

List of Tables

	Page
1. DoD Cost Management Competency Deficiencies	3
2. Program Management Professional Development	6
3. Levinson's 20 Dimensions of Leaders' Personalities.....	18
4. Course Selection Rankings	19
5. Thornberry's Core Dimensions	20
6. PMBOK Cost Management Elements	21
7. Posner's Problems and Skills	23
8. Cadbury-Schweppes Model	25
9. Androgynous Competencies	25
10. Logistics Manager Attributes	26
11. Pettersen's Predictors	28
12. Gadeken's Program Management Model (Form 1).....	33
13. Gadeken's Program Management Model (Form 2).....	33
14. PMBOK, DSMC PMC, DBOK Model Comparisons	35
15. AMFB Program Management Model	36
16. Model Structure	39
17. Bloom's Taxonomy of Learning	40
18. Cost Management Competency Model.....	41
19. Target Sample Size by Instrument Version and Position Level	44
20. Frequency Response Scale.....	50

	Page
21. Importance Response Scale	50
22. Pre-Test Question Response Rate	52
23. Frequency Response Scale Comparison	53
24. Group Kruskal-Wallis Tests.....	57
25. Internal Consistency Correlation	59
26. Internal Consistency Differences	60
27. Most Frequently Used Competencies.....	66
28. Least Frequently Used Competencies.....	66
29. Most Important Competencies.....	68
30. Least Important Competencies.....	68
31. Tier One Competencies (Most Valuable)	69
32. Tier Two Competencies.....	70
33. Tier Three Competencies.....	70
34. Management Education Respondents.....	75
35. Organization Type Respondents	75
36. Primary Program Activity Respondents.....	76
37. Position Level Respondents	76
38. Frequency Differences Based on Management Education.....	77
39. Importance Differences Based on Management Education	77
40. Frequency Differences Based On Organization Type.....	78
41. Frequency Differences Based On Primary Activity	80

	Page
42. Importance Differences Based on Primary Activity	81
43. Frequency Differences Based On Position Level	82
44. Importance Differences Based On Position Level.....	82
45. Open-Ended Response Topics	84

Abstract

The magnitude of money involved in the acquisition of defense systems and the public scrutiny resulting from cost overruns and program failures make cost management competence critical to program success. This research examined the cost management competencies required of defense program managers. A cost management competency model was developed from a foundation of past research. The model was evaluated through a mail survey of 682 intermediate and senior level military program managers in Air Force Materiel Command. The results provided by the 330 respondents indicate that 29 of the 47 competencies in the model were valuable to the program managers. The results indicate that both intermediate and senior level program managers rely more on understanding cost management concepts than on being able to complete the tasks themselves. Data analysis identified differences in the perceived importance and frequency of use of some competencies based on management education, organization type, primary program activity, and position certification level. The results have direct implications for the development of defense program managers. Education and training programs can be improved by focusing on the cost management competencies that will be most valuable to program managers in the field.

COST MANAGEMENT COMPETENCIES FOR DEPARTMENT OF DEFENSE PROGRAM MANAGERS

I. Introduction

Background

Over 35 percent (\$92 billion in 1993) of the Department of Defense (DoD) budget has historically been allocated to acquisition organizations within the DoD for the purposes of accomplishing the research, development, and procurement of systems in support of national defense (Cheney, 1993:143). However, the public's perception of how these funds are managed has been tainted by numerous weapon system acquisition "scandals" which resulted in overruns costing taxpayers billions of dollars.

"Creating a Professional Acquisition Work Force" by Congressman Nicholas Mavroules gives insight into the history of problems associated with the acquisition of defense systems. In 1991, Representative Mavroules was the chairman of the Subcommittee on Investigations, Committee on Armed Services, U.S. House of Representatives. In his article, Representative Mavroules states that the scandals that arose within the acquisition community during the 1980s were nothing new. They date back to the Navy's contract for its first warship, the USS Constitution, which overran by 175 percent (Mavroules, 1991:15). Three more recent examples of DoD acquisition overruns and cost mismanagement are described in the following paragraphs.

The National Aerospace Plane (NASP) was conceived as a cooperative effort between the Air Force , the Navy, and the National Aeronautics and Space Administration (NASA) to design a futuristic, hypersonic, high-altitude air vehicle. Politicians have criticized the NASP program because of the inaccuracy of the cost estimates. For NASP, "total program cost now is estimated at \$12-15 billion, roughly three times the initial estimates" (Scott, 1993:23). Future funding is expected to be more consistent with the original estimates, which fall well short of updated estimates. Thus, the future of the NASP program is uncertain (Oliver, 1994).

The Navy's A-12 was intended to be the stealth attack aircraft that would take the Navy into the next century. The contract for the A-12 was terminated for default in 1991 (USGAO, 1991:2). Significant contributors to that program's downfall included the inappropriate use of a fixed price contract for development and the uncertainty created by the improper use of cost and schedule control data for reporting program estimates at completion (Morrison, 1991:31; Christensen and Heise, 1993). As of July 1991, the Navy A-12 contractor team had filed a termination for convenience proposal and claim for a settlement worth between \$1.3 billion and \$1.9 billion. The contractors are seeking all incurred costs, a reasonable profit, and settlement expenses (USGAO, 1992:6).

The C-17 is the Air Force's next generation transport aircraft. Technical shortfalls in the C-17 resulted in excess of \$1 billion in cost overruns. In addition, certain government program personnel, including the former program manager, were disciplined for advancing the prime contractor nearly \$500 million in unjustified progress payments

(Morocco, 1993b:51). As of January 1993, McDonnell Douglas was preparing over \$1 billion in claims for costs incurred on the C-17 program (Morocco, 1993b:51).

Table 1 represents a sample of pertinent articles and General Accounting Office reports identifying various cost management deficiencies as a significant source of DoD acquisition failures such as those mentioned above.

Table 1. DoD Cost Management Competency Deficiencies

	AWS	AWSS	Chri	Chri	CQW	CQW	E	F	F	F	G	G	G	G	G	M	M	M	S	S	V
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	a	b	a	b	a	b	3	a	b	c	0	a	b	c	a	b	d	1	a	b	3
Economic Conditions							X		X				X				X				X
Financial Statement Analysis																					X
Time Value of Money											X										
Contractor Financing	X				X						X	X	X	X	X	X	X	X	X	X	X
Cost Estimating			X								X	X	X		X	X		X	X	X	X
Statistical Analysis (Risk)			X																		
Software Tools			X	X																	
Management Reserve																			X		
Inflation Factors											X										
Production Rate and Quantity										X	X						X				X
Budget Cuts/Unit Cost		X			X	X				X	X					X		X			X
Cost Elements (Dir. Labor, G&A, etc.)													X								
Cost Characterization (Fixed vs. Variable)																					
Break-Even Analysis																					
Reasonableness, Allowable, Allocable	X											X	X	X	X	X	X				X
Learning Curves																					
Work Breakdown Structure																					
Planning, Programming and Budgeting System																					
Congressional Budgeting and Appropriations												X	X			X					X
Commitments, Obligations, Expenditures	X											X	X	X	X	X					
Performance Measurement Baseline (PMB)			X	X												X					
Cost Accounting & Control Systems (C/SCSC)			X	X											X				X		
Contract Type						X						X	X	X	X	X	X	X	X	X	X
Political Environment	X	X			X	X					X	X	X	X	X	X	X	X	X	X	X
Congressional Reporting												X	X	X	X	X	X	X	X	X	X
Scope Changes		X			X					X	X				X		X	X	X	X	X
Earned Value			X	X								X	X			X				X	
Estimates at Completion (EAC)			X	X											X	X			X		
Cost Reports (CPR, CSSR)			X	X												X					
Corrective Actions	X				X							X	X			X	X	X	X	X	X

Table 1 illustrates the wide variety of cost management competencies that, having been neglected, resulted in cost overruns and program failures. In particular, contractor financing, cost estimating, scope changes, corrective actions, and operating within the DoD political environment have been frequently cited as areas of competency deficiencies.

Media reports of cost mismanagement on the NASP, C-17, A-12 and other programs prompted investigations into every aspect of the business of defense systems acquisition. Since World War II, there have been at least six major commissions that have looked into the problems of military acquisition: the Hoover Commissions of 1949 and 1955, the Fitzhugh Commission of 1970, the Commissions on Government Procurement in 1972, the Grace Commission of 1983, and the Packard Commission of 1986. In 1986, the Packard Commission, also known as the President's Blue Ribbon Commission on Defense Management, issued a final report stating that the acquisition workforce was undertrained, underpaid, and inexperienced (Cheney, 1989:12; President, 1986). The other commissions also recognized the need for a competent work force, yet their findings were never implemented in the form of legislative and policy improvements (Mavroules, 1991:18). Until 1991, the legislation focused primarily on only two of three elements within the acquisition system: the process and the structure. In 1991, Congress acted on the third element -- the people (Mavroules, 1991:16).

Following numerous inquiries and investigations, legislators agreed with the Packard Commission's finding that the lack of experience and appropriate training of acquisition personnel was a significant shortfall within the acquisition system. In an effort to reduce costly mistakes in the arena of defense systems acquisition, Congress passed the Defense

Acquisition Workforce Improvement Act of 1990 (DAWIA). This legislation required DoD to establish a professional acquisition workforce with training and experience commensurate with the responsibilities of the many types of acquisition positions. DAWIA also required the establishment of a highly trained, educated, and experienced acquisition corps to fill the most critical acquisition positions (US Congress, 1990:Sec. 1722, 23, 31).

Department of Defense Directive (DODD) 5000.52, Defense Acquisition Education, Training, and Career Development Program, and DOD 5000.52M, Career Development Program For Acquisition Personnel, implemented DAWIA. These documents required the armed services to establish and maintain systems by which acquisition personnel would be certified at various levels, based on their acquisition experience, education, and training (DODD 5000.52, 1991:2). The Air Force certification program is currently called the Acquisition Professional Development Program (APDP) (IG, 1992). This program replaced the previous Air Force initiative known as the Acquisition Management Professional Development Program (AMPDP). Table 2 highlights the differences between the AMPDP requirements for program managers and those subsequently required by DOD 5000.52M.

The Air Force was pleased with the AMPDP certification requirements because the AMPDP certification program "successfully identified personnel with the qualifications needed to manage complex acquisitions" (IG, 1992:10). However, as Table 2 indicates, DOD 5000.52M certification requirements were not as stringent.

Many Air Force acquisition personnel felt the resulting uniform, but rather easily met, OSD certification requirements would not stimulate development of the professional acquisition corps intended by the DAWIA and envisioned by senior Air Force Leadership. (IG, 1992:9)

Table 2. Program Management Professional Development

	AMPDP	DOD 5000.52M
LEVEL I		
Education	≥ Bachelors degree	(D) Bachelors Degree Technical or Business
Experience	One of: - 6 months min. Program Office - Fully Qualified Acquisition AFSC	(M) 1 yr Acquisition
Training	SAS-001 or Equivalent	(M) 1 Basic Acquisition Course (D) An Additional Acquisition Course
LEVEL II		
Education	≥ Squadron Officers School	(M) None (D) Masters in Engineering, Systems Management, or Appropriate Field
Experience	2 yrs min. Program Office & one of: - 1 yr Operations - 2 yrs AFSC/AFLC other experience - 2 yrs Headquarters	(M) ≥ 2 yrs acquisition (D) ≥ 2 Additional yrs acquisition Preferably in Program Office or Similar Organization
Training	SYS-200 2 Additional Acquisition-related Specialty Courses	(M) Intermediate Systems Acquisition Course (D) DSMC-PMC or comparable course (D) Management & Leadership Training
LEVEL III		
Education	≥ Masters Degree ≥ Intermediate Service School	(D) Masters in engineering, systems management, or appropriate field
Experience	3 yrs cum. Program Office & one of: - 2 yrs Headquarters - 1 yr 2nd Program Office - 1 yr Operations - 2 yrs AFSC/AFLC other experience	(M) ≥ 4 yrs in Acquisition (≥ 2 in PO or Similar Organization) (D) Additional 4 yrs Acquisition
Training	SYS-400 or Equivalent	(D) DSMC-PMC or Comparable Course (D) Management & Leadership Training
LEVEL IV		
Education	Senior Service School	
Experience	8 yrs Total Acquisition 2 yrs Project Management	
Training	DSMC-PMC or Equivalent	

(IG, 1992:12)

The Air Force sought to compensate for the new, lower standards imposed by DOD 5000.52M by requiring higher standards in their APDP, the replacement for the AMPDP. Specifically, the original APDP requirements included four years acquisition experience for Level II certification and eight years acquisition experience for Level III certification. DOD 5000.52M only required two years acquisition experience for Level II and four years for Level III. The APDP also required completion of the Defense Systems Management College Program Management Course (DSMC PMC). This course was not required by DOD 5000.52M (IG, 1992:12). The Air Force's attempts to use these higher standards in their APDP than the other services were using in their certification programs met strong resistance from the DoD because the different standards made it more difficult to assess the qualifications of the services' acquisition workforces, to compare individuals among the services, and to measure compliance with DAWIA.

The Air Force fought for higher standards because Air Force acquisition personnel were typically more experienced and had more acquisition education and training than their contemporaries in the Army and Navy, and the Air Force believed the higher standards would provide a better measure of an individual's ability to manage complex acquisitions (IG, 1992:9). However, the Air Force's attempts to maintain standards above those required under DOD 5000.52M were abandoned in early 1994 (Druyun, 1993). Arguments for uniformity among services prevailed over the Air Force's desire for higher standards. Air Force APDP requirements are now fully consistent with the DoD requirements and those of the other services.

The APDP certification criteria are general in nature. There are no explicit requirements for training, education, or experience for program managers in specific areas like cost management. Therefore, the tools to manage education and training programs at a detailed level are limited. Competency models in specific areas like cost management would provide the needed tools for creating and managing programs to develop acquisition workforce competence. *The American Heritage Dictionary* (Heritage, 1982:301) defines the word **competent** as:

1. Properly or well qualified; capable.
2. Adequate for the purpose; sufficient.
3. Legally qualified or fit; admissible.

For the purposes of this thesis, the term **competency** will be interpreted as a capability required for proficient program management. When program managers possess such an ability, that means they possess the skills and knowledge, as well as the physical and mental characteristics necessary to successfully complete a task or understand a particular aspect of cost management. (Note: The terms program manager and project manager are used interchangeably throughout this thesis, as are program management and project management.)

Accurate identification of what program managers need to know and do can maximize the benefit of time and money spent on education and training programs. For many program managers, formal cost management training may be limited to the few hours provided during general acquisition courses like PMT 101, Fundamentals of Systems Acquisition Management, and PMT 201, Intermediate Systems Acquisition

(DAU, 1993:74). However, for an aspect of program management as critical as cost management, these overviews may not be sufficient.

Although the criteria of experience, education, and training are necessary to reflect an employee's exposure to various aspects of the acquisition process, they may not be sufficient to distinguish the qualifications of one acquisition professional from another, and they may not accurately reflect the demands placed on program managers in their day-to-day activities. These criteria simply measure attendance at professional development courses and job locations; they do not measure a person's competence in acquisition activities. Incorporation of competencies into the education, training, and certification systems would pull employees to the level of competence needed to successfully manage complex acquisitions. In other words, the standards governing service needs should not be driven by what the services currently have or what the training/education system is currently able to provide. The standards need to originate from the demands that are placed on acquisition personnel in their day to day activities.

This thesis is based on the premise that, although education, training, and experience are not sufficient to guarantee competence, they are common vehicles through which individuals develop competence. Although quantifying a person's competence is difficult to do, identifying those competencies required for success is achievable and necessary for the purpose of developing training programs, education, career progression plans, and useful certification criteria.

Problem Statement

The 1989 Defense Management Report to the President clearly states the general problem area addressed by this thesis:

The defense acquisition workforce mingles civilian and military expertise in numerous disciplines for management and staffing of the world's largest procurement organization. Each year billions of dollars are spent more or less efficiently, based on the competence and experience of these personnel. Yet, compared to its industry counterparts, this workforce is undertrained, underpaid, and inexperienced. Whatever other changes may be made, it is vitally important to enhance the quality of the defense acquisition workforce -- both by attracting qualified new personnel and by improving the training and motivation of current personnel. (Cheney, 1989:12)

Models identifying the competencies required of program managers could provide valuable information for establishing certification criteria and for designing training and education programs for program managers. This research effort evaluated competencies for the cost management area. For the purposes of this research, intermediate and senior level program managers are defined as those program managers who occupy positions coded as APDP Program Management Level II and Level III, respectively. Using this definition, a Level II program manager must have at least two years acquisition experience, and a Level III program manager must have at least four years acquisition experience (IG, 1992:12).

Research Questions

1. What cost management competencies are of value to intermediate and senior level DoD program managers?

A. What cost management competencies are perceived to be important by program managers?

B. How frequently are specified cost management competencies used by program managers?

2. Is there significant variance in the competencies required of subgroups of this population?

A. Is there significant variance in the competencies valued by those in intermediate and senior level positions?

B. Is there significant variance in the competencies valued based on differences in management education?

C. Is there significant variance in the competencies valued by those working with different primary program activities?

D. Is there significant variance in the competencies valued by those working in different types of organizations?

Scope

Although competencies in a wide spectrum of disciplines such as engineering, contracting, logistics, and cost management contribute to program management success, this effort focused on a single area within the broader discipline of program management. In particular, this research focused on identifying the cost management competencies valued by intermediate and senior level military program managers below the rank of brigadier general. Competencies were also evaluated based on the demographic subgroups of organization type, program phase, certification required for the position, and the type of management education.

Key Terms

The following key terms are taken from DOD 5000.52-M, Career Development Program For Acquisition Personnel.

Acquisition. The planning, design, development, testing, contracting, production, introduction, acquisition logistics support, and disposal of systems, equipment, facilities, supplies, or services that are intended for use in, or support of military missions.

Acquisition Corps. A subset of DoD Component's acquisition workforce, composed of selected military and civilian personnel in grades of Lieutenant Commander, Major, General Schedule and/or General Manager (GS/GM) 13 and above, who are acquisition professionals. There is one Acquisition Corps for each Military Department and one for all the other DoD Components (including the OSD and the Defense Agencies).

Acquisition Experience. Experience gained while assigned to an acquisition position. Also includes intern, exchange, education or training with industry, and other acquisition developmental assignments. Includes experience in DoD acquisition positions and in comparable positions outside the Department of Defense.

Acquisition Organization. An organization, including its subordinate elements, whose mission includes planning, managing and/or executing acquisition programs which are governed by DoD Directive 5000.1, DoD Instruction 5000.2, and related issuances.

Acquisition Positions. Civilian positions and military billets that are in the DoD acquisition system, have acquisition duties, and fall in an acquisition position category established by the USD(A). While most frequently located in organizations having an acquisition mission, acquisition positions are also located in management headquarters organizations, management headquarters support organizations, and other organizations.

Acquisition Program. A directed, funded effort that is designed to provide a new or improved materiel capability in response to a validated need.

Acquisition Workforce. The personnel component of the acquisition system. The acquisition workforce includes permanent civilian employees and military members who occupy acquisition positions, who are members of an Acquisition Corps, or who are in acquisition development programs.

Certification. A process through which it is determined that an individual meets all the education, training, and experience standards established for his or her acquisition career field or position, or for membership in an Acquisition Corps.

Critical Acquisition Position. Those senior positions carrying significant responsibility, primarily involving supervisory or management duties, in the DoD

acquisition system. Those positions are designated by the Secretary of Defense, based on the recommendations of the DoD Component Acquisition Executives, and include any acquisition position required to be filled by an employee in the grade of GS/GM 14 or above, or military grade O-5, or above. Also specifically includes all the Program Executive Officers (PEOs), the Deputy PEOs, the PMs and the Deputy PMs for major defense acquisition programs, and the PMs of significant non-major programs.

Mandatory DoD Acquisition Course. A course of study that has been identified by the USD(A) as meeting an established DoD education and training requirement. These courses provide a common, non-component-specific foundation of knowledge for each acquisition function. Each of the following courses is mandatory within one or more career programs or is mandatory to qualify for certain assignments, or both:

a. **Career-development Mandatory Course.** A course that must be taken for an employee to be certified at Level I, II or III within one of the career fields.

b. **Qualification Mandatory Course.** A course that must be completed for an employee to be eligible to perform certain duties or to be given certain assignments.

Program Manager (PM). A military or civilian official who is responsible for managing an acquisition program.

Program Office. An acquisition office with the mission to plan, manage, or execute an acquisition program. [Used interchangeably with System Program Office (SPO)].

Summary

Scandals and failures in defense acquisition such as those encountered on the Air Force C-17 and the Navy A-12 programs have plagued the Department of Defense for years, resulting in negative publicity and increased scrutiny. Numerous review committees have attempted to improve the process and structure of the defense acquisition system. In addition to the process itself, recent efforts have also focused on the people involved in DoD acquisition. There has been a concerted effort to improve the quality of the acquisition workforce through legislation such as DAWIA and service programs such as

APDP. Education and training play a major role in this improvement process. In order to maximize the benefit gained for the time and money invested in education and training, it is critical to focus these programs on the tools that will be most valuable to program managers in their jobs. This thesis was an attempt to address the cost management competencies required of Air Force program managers.

Chapter 2 documents efforts made to date to improve the acquisition workforce and to identify the competencies required of program managers. Studies of program management skills, traits, and competencies are discussed, as are the few studies that address cost management directly. Chapter 3 describes the development of the competency model, the sampling approach, survey instrument development, and the data analysis procedures. The findings and results of the analysis are presented in Chapter 4. Chapter 5 presents the conclusions of this effort and recommendations for further study.

II. Literature Review

Overview

This chapter documents the findings of an extensive literature review. First, a brief description of the unique nature of DoD program management is given. Then, a review of general management and project management models is presented chronologically in two sections: Private Sector Research and Government Research. This review of applicable literature, cost management models, and relevant lessons learned from previous DoD acquisition programs lays the foundation for development of a cost management competency model, to be addressed in Chapter 3, Methodology.

The Nature of DoD Program Management

The Project Management Institute (PMI) is a professional organization formed to advance "the state-of-the-art in the management of projects" (Wideman, 1987:1-1). In its Project Management Body of Knowledge (PMBOK), a model which identifies the critical aspects of project management, PMI defines project management as, "The art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, quality, and participant satisfaction" (PMI, 1987).

The unique nature of project management can best be described in the context of the characteristics of a program. Nicholas presents several characteristics of a project. A project involves a single, definable purpose, end-product or result, which is usually specified in terms of cost, schedule, and performance requirements.

Projects require skills from multiple professions and organizations, thus they cut across organizational lines. Projects are also temporary, one-time activities, never to be exactly repeated again (Nicholas, 1990:3-4).

These project characteristics may be applied to any project, and they distinguish the project management environment from other types of management characterized by on-going, repetitive activities. The PMBOK further distinguishes traditional management from project management by identifying the following characteristics of managing an established on-going enterprise:

- Life in an on-going enterprise is relatively simple and certain for extended periods of time.
- Relatively large quantities of goods or services are produced per given time period.
- Tasks are generally repetitive, continuous or exhibit substantial similarity.
- Roles and relationships are well understood, having developed and adjusted over long periods of time, and
- The work environment is relatively stable.

None of these are true in a project environment. In a sense every project is unique, if only by virtue of its own set of constraints, although indeed there may be many projects of a similar nature. (Wideman, 1987:1-1)

Despite these differences, many of the cost management tools used in DoD program management are also used throughout industry. However, the literature reviewed for this research is presented in the context of the DoD acquisition environment, which includes not only the characteristics of a project listed above, but also the effects of working with public funding in a socially and politically charged environment.

Private Sector Research

Researchers in the private sector have conducted studies and analyses in a variety of areas related to program management. Several relevant studies are presented chronologically below.

Levinson

Harry Levinson looked at personality criteria that could be used to select senior executives (Levinson, 1980:113-120). Levinson's work was not directed toward the military program manager, although senior managers in both industry and DoD environments may rely on similar skills. Levinson conducted no formal research to validate the components in his model and in fact stated, "I make no claim for statistical validation of the dimensions or that the scales represent equal intervals or accurate measures" (Levinson, 1980:119). Levinson's work was, "a way of calling attention to, and examining facets or dimensions of personality that relate to executive success" (Levinson, 1980: 119). Levinson's 20 "Dimensions of Leaders' Personalities" are listed in Table 3.

Table 3. Levinson's 20 Dimensions of Leaders' Personalities

Thinking
• Capacity to Abstract
• Tolerance for Ambiguity
• Intelligence
• Judgment
Feelings, Interrelationships
• Authority
• Activity
• Achievement
• Sensitivity
• Involvement
• Maturity
• Interdependence
• Articulateness
• Stamina (Physical and Mental)
• Sense of Humor
• Adaptability
Outward Behavior
• Vision
• Perseverance
• Personal Organization
• Integrity
• Social Responsibility

(Levinson, 1980: 113-120)

Kerzner

Another study emphasizing the educational aspect of developing project management competencies was conducted by Dr. Harold Kerzner. He surveyed 392 PMI members and asked them to rank, in order of preference, courses they thought were, or would be, important to their professional development (Kerzner, 1981:38). The results of this study are presented in Table 4.

Table 4. Course Selection Rankings

Course	# of times identified out of 177 responses
Fundamentals of Project Management	160
Planning and Control	142
Accounting and Finance	139
Organizational Behavior	122
Systems Management/Organizational Theory	121
Law	109
Information Systems	109
Management Policy	105
PERT/CPM	97
Computers	79
Management Science	75
Managerial Economics	71
Government, Management, Environment	70
Production Management	68
Statistics	55
Marketing	55
Multinational/International Trade	45
Quality Control	39

(Kerzner, 1981:42)

Table 4 indicates the perceived relative importance of education and training in various aspects of project management. One other important point Kerzner emphasizes is that most of the managers surveyed felt "that project managers cannot be trained in an academic environment and that colleges and universities should provide only the necessary tools for general project management and leave the formal training to the companies themselves" (Kerzner, 1981:43). He further highlighted the need for courses to focus on application, not theory (Kerzner, 1981:44).

Thornberry and Others

Thornberry's team conducted an empirical study to "examine a sample of project managers to determine the fundamental skills and abilities necessary for project management success" (Thornberry et al., 1983:73). His sample consisted of 110 male project managers who were identified by their supervisors as successful project managers (Thornberry et al., 1983:74). Thornberry's study was multi-faceted, involving two weeks of time log keeping, personality testing, and personal interviewing with a sample of the participants. The personal interviews involved discussion of a successful and a failed project management incident in which the participant was involved. The 16PF (personality factors) test was used to identify common personality traits (Thornberry et al., 1983:74). Table 5 shows Thornberry's five "core dimensions" of program management.

Table 5. Thornberry's Core Dimensions

1. Oral Communications
2. Influencing Skills
3. Intellectual Capabilities
4. Ability to Handle Stress
5. Works Skills (planning, organizing, delegation, and decision making)

(Thornberry et al., 1983:73-76)

Project Management Institute

The PMI PMBOK (previously introduced) was designed to be a "well-defined body of knowledge (BOK) that can be studied and learned through formal education" (Stuckenbruck, 1986:25). Table 6 shows the PMBOK's detailed cost management model, including the elements PMI believes are necessary for a well-defined body of knowledge. Table 14 illustrates how cost management fits into the complete PMBOK.

Table 6. PMBOK Cost Management Elements

Cost Estimating & Forecasting	Cost Budgeting	Cost Controls	Cost Applications
Economic Analysis - feasibility study	Work Breakdown Structure	Definitions	Historical Data Banks
Profitability - payout time - - ROI, NPV, DCF, IRR	Code of Accounts	Policies	Responsibility Charting
Financing	Budget Cost - cost plan - estimate conversion	Procedures	Post Project Evaluation
Prospectus	Cash Flow Forecast		
Project Investment Cost - order of magnitude estimate - concept estimate - budget estimate - design reviews - definitive estimate - project close out & start up cost	Managerial Reserves	Systems Flow Diagrams Contingency Management - scope changes - schedule changes - claims - unidentified probable risk - reserves	Life Cycle Costing Value Analysis
Contingency Allowance	Performance Measurement Baseline	Monitoring Actuals Vs. Budgets - Pareto's law	Computer Applications - data presentation
Inflation / Escalation Allowance	Project Cost System - project accounting	Variance Analysis - cost variance - % over/under - unit variance analysis - variance since last period - schedule / performance	
Interest During Execution	Funding - at appropriation procedures	Integrated Cost/Schedule Reporting - BCWS - BCWP - ACWP - "S" curves - cash flow actuals	
Forecasting - historic performance analysis - regression analysis - unit and marginal costing - projected performance		Progress Analysis/Reporting - cost performance index - schedule performance index - productivity	
Statistics - range analysis - risk analysis - confidence levels		Corrective Action - alternatives	

(Georgas and Stelco, 1987:D-1)

Einsiedel

Albert Einsiedel developed a non-empirical model of project management skills or traits. His efforts were directed at uncovering characteristics which make project managers successful (Einsiedel, 1987:51). Einsiedel's research provides a valuable insight: Not all projects are equally sensitive to the efforts of the leader (Einsiedel, 1987:51). He notes, "The importance of obtaining a proper match between the individual's characteristics and the role requirements is directly related to the degree to which the project is leader sensitive." (Einsiedel, 1987:54). Einsiedel presents the following five "Characteristics of an Effective Project Leader" (Einsiedel, 1987:53-4):

1. Credibility
2. Creative Problem-solver
3. Tolerance for Ambiguity
4. Flexible Management Style
5. *Effective Communication Skills*

Posner

Barry Posner conducted an empirical study of project managers. He received almost 1400 response items from 287 respondents to two open-ended questions:

- 1) What factors or variables are *most* likely to cause you problems in managing a project?; and
- 2) What *personal* characteristics, traits, or skills do "above average" project managers use (or use better than their peers)? (Posner, 1987:107)

Participants included 189 men and 98 women and ranged from 22 to 60 years old.

Posner categorized the responses to both questions as shown in Table 7 (the percentage of respondents identifying the particular area in their response is in parenthesis).

Table 7. Posner's Problems and Skills

Problems	
1. Resources Inadequate (69%)	
2. Meeting (unrealistic) deadlines (67%)	
3. Unclear goals / direction (63%)	
4. Team members uncommitted (59%)	
5. Insufficient planning (56%)	
6. Breakdowns in communications (54%)	
7. Changes in goals / resources (42%)	
8. Conflicts between departments or functions (35%)	
Skills	
1. Communication (84%)	<ul style="list-style-type: none"> • listening and persuading
2. Organizational Skills (75%)	<ul style="list-style-type: none"> • planning • goal setting • analyzing
3. Team Building Skills (72%)	<ul style="list-style-type: none"> • empathy • motivation • esprit de corps
4. Leadership Skills (72%)	<ul style="list-style-type: none"> • sets example • energetic • vision (big picture) • delegates • positive
5. Coping Skills (stress management) (59%)	<ul style="list-style-type: none"> • flexibility • creativity • patience • persistence
6. Technological Skills (46%)	<ul style="list-style-type: none"> • experience • project knowledge

(Posner, 1987:108)

There are some similarities between the most common problems and the most valued skills. For example, breakdowns in communication make communication skills valuable, and unclear goals, insufficient planning, and changes in goals make organizational skills critical.

Cadbury-Schweppes

Cadbury-Schweppes conducted an extensive research program involving program manager competencies. Utilizing a variety of approaches, Cadbury developed a "competency language" describing "Dimensions of Management" (Glaze, 1989:72-78). Cadbury's use of assessment centers results in more emphasis on the requirements of individual positions than on the profession as a whole (Glaze, 1989:72-78). In this context, precise definitions of the requirements for individual positions run contrary to the definition of a generic set of program manager competencies, unless that set is so general that it provides little basis for differentiation between applicants.

Cadbury-Schweppes developed a six cluster model for dimensions of management that they use to profile both positions and managers (Glaze, 1989:73, 76-77). They started with 40 behavioral competency definitions that had been developed by a consultant. Cadbury-Schweppes modified this list to arrive at a list of 50 competencies. These 50 competencies were then divided into six categories (clusters) as indicated in Table 8. Although no formal validation has been accomplished on this particular competency model, Cadbury-Schweppes claims validation through years of successfully using the model as a tool in personnel offices for profiling employees, assessing potential performance, and establishing training needs for individual positions.

Table 8. Cadbury-Schweppes Model

1. Strategy
2. Drive
3. Analysis
4. Implementation
5. Personal Factors
6. Influence
• relationships
• persuasion
• leadership
• followership

(Glaze, 1989:76)

Sargent and Stupak

Sargent and Stupak saw a trend in program management toward inclusion of characteristics and techniques regarded as more feminine. In doing so, they move away from traditional masculine characteristics and propose the set of seven androgynous program manager competencies shown in Table 9 (Sargent and Stupak, 1989:29-35).

Table 9. Androgynous Competencies

1. Technical Competence
2. Problem-Solving Competence
3. Self-Awareness
4. Interpersonal
5. Team Leadership and Membership
6. Entrepreneurial
7. Leadership

(Sargent and Stupak, 1989:34-5)

Williams and Currey

Williams' and Currey's study was directed toward logistics managers. They developed their model through analysis of the contents of the want ads in an Australian

newspaper. They looked for the most commonly noted skills or attributes in those ads. The study included a sample of 70 ads gathered over a 15 month period (Williams and Currey, 1990:370). Their presumption that companies write their valued management skills into the ads seems logical. However, the authors note that "There may be attributes not advertised for reasons of economy of expression, racial bias, gender bias and other unstated biases" (Williams and Currey, 1990:369). Williams' and Currey's "desired attributes for logistics managers" are shown in Table 10.

Table 10. Logistics Manager Attributes

Skills
• Communication
• Personal Relations / Leadership
• Factual Logistic Knowledge
• Money Flow Management Evaluation
• Computer Literacy
Experience
• Large Organizations
• Proven Track Record
• At least 5 years Management Experience
Qualities / Qualifications
• Motivated and Creative
• Pleasant, Courteous and Professional
• Contributes to Firm's Objectives
• Independent and Accountable
• Tertiary Qualifications

(Williams and Currey, 1990:375)

The elements of this model are similar to some of the other models presented here, but computer literacy and independence are not frequently encountered in the other

models. Williams and Currey indirectly address one issue of this study in considering what their model implies for education (Williams and Currey, 1990:377). The authors note:

If the results of this study are any guide, logistics syllabi must take a holistic perspective. The study not only identified the importance of the traditional topics of materials management, inventory management, warehousing and transport, but also identified the importance of related subjects of accounting, communication, psychology and computing. (Williams and Currey, 1990:377)

Williams and Currey reference another relevant study conducted by Poist and Mattingly which found that "post bachelor-degreed logistics personnel attached a higher importance to quantitative techniques than personnel with less education (Williams and Currey, 1990:376). A similar phenomena may be present in project management circles wherein certain competencies are valued more by personnel with more education and training.

Pettersen

Pettersen derived a set of predictors for program manager success. These predictors (Table 11) were based solely on the results of other studies as documented in over 60 publications (Pettersen, 1991:21-2).

Table 11. Pettersen's Predictors

Other Personal Qualities
• Need to Achieve and Proactivity
• Self-Confidence, Maturity, Stability
• Loyalty, Honesty, Integrity
• Tolerance Towards Ambiguity
• Interest in the Job
Interpersonal Relations
• Oral Communication
• Influence
• Ascendancy
Supervision and Project Team Management
• Delegation of Responsibilities
• Team Structuring
• Consideration Towards Team
• Team Member Development
• Teamwork, Flexibility, Cooperation
• Resolving Conflicts
Administration
• Planning and Organization
• Control
• Strategy and Organizational Know-How
• Specialized Knowledge
Problem Solving
• Problem Analysis
• Judgment and Practical Sense
• Decisiveness

(Pettersen, 1991:22)

Thamhain

Thamhain investigated "the effectiveness of various approaches to project management training and development as perceived by managers in the field" (Thamhain, 1991:39). His conclusions were based on interviews and records reviews of 220 project

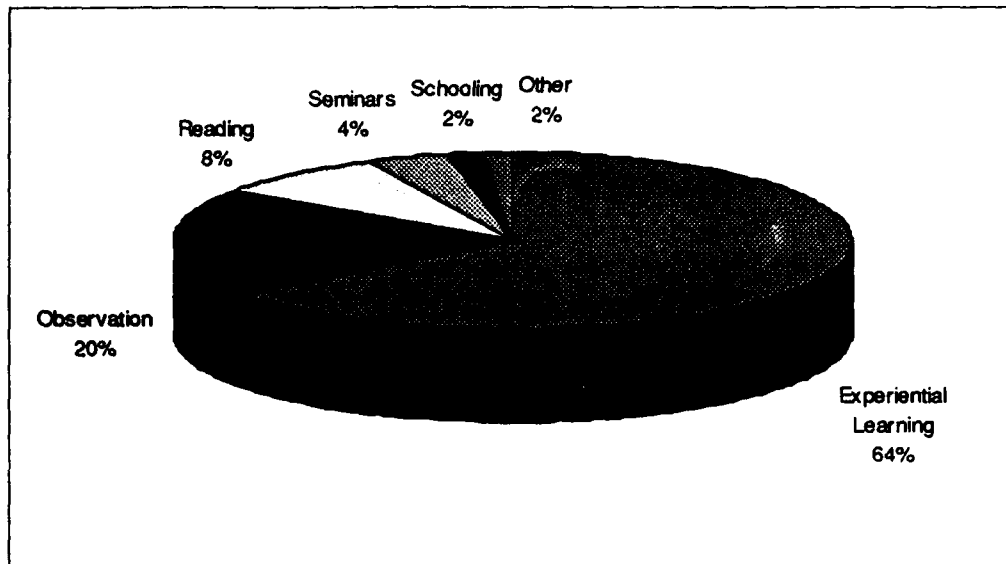
managers from 18 companies and business divisions, having annual operating budgets ranging from \$2.5 million to \$15 billion (Thamhain, 1991:39).

Thamhain identified leadership/interpersonal, technical, and administrative skills as the primary areas of concern for developing project management training programs. He then asked project managers to indicate, from the 12 methods below, which were most desirable for developing overall competence in project management.

1. Experiential Learning
2. Observing Management Practice
3. Formal On-The-Job Training
4. Literature Reading
5. Coaching By Upper Management
6. Seminars and Workshops
7. Formal Courses (Degree)
8. Consulting (Internal and External)
9. Professional Conferences
10. Special Work Groups
11. Formal Courses (Continuing Education)
12. Job Rotation

Then, the project managers were asked to indicate the training methods' approximate contribution to professional development, relative to other methods (Thamhain, 1991:44).

Figure 1 shows the significance of various training methods as perceived by the project managers in Thamhain's research. Figures are rounded to the nearest whole percent.



(Thamhain, 1991:41)

Figure 1. Contribution of Skill Development Methods

Kanungo and Misra

Kanungo and Misra attempt to distinguish between managerial skills and competencies. They state that competencies refer to the mental capabilities that lead to successful adaptation to the real-world context, especially for non-routine tasks in a volatile environment. These capabilities are the inner resources that managers possess. Skills on the other hand, are needed for tasks that are routine or programmed in a stable environment. Without accompanying competencies, these technical and routine task related skills will remain dormant (Kanungo and Misra, 1992:1322).

Kanungo and Misra reject the idea of a single set of competencies when they reference past studies showing that both academic standing and past job performance are poor predictors of future performance because of variance in managerial positions and difficulty in specifying requirements (Kanungo and Misra, 1992:1313). Kanungo and

Misra provide a set of three general categories of competencies: affective, intellectual, and action-oriented. A more detailed break-out of the components of these three competencies is provided below (Kanungo and Misra, 1992:1323-29).

1. Affective Competence
 - Controlling primitive terminal reactions in situations that produce strong emotions
 - Developing equanimity and problem orientation
 - Delay of gratification
 - High proactive involvement, enthusiasm, interest, and commitment to meeting challenges of life
2. Intellectual Competence
 - Intellectual competence to solve problems
 - Self-reflection for strengthening self-efficacy belief
3. Action-Oriented Competence
 - Task-related action orientation with regard to goal and plan development and use of feedback
 - People-related action orientation

Kanungo and Misra's model has not been validated by research, but rather it is a review and critique of relevant literature.

Government Research

Smythe and McMullan

An effort by Smythe and McMullan compared program manager skills required in various phases of the acquisition process. The results of personal interviews with 24 System Program Directors for major programs indicated that different skills are required throughout the life of a program (Smythe and McMullan, 1975:41). This result casts doubt on the validity of using a single set of competencies for all positions since program managers may be involved with a program during more than one phase. Smythe and McMullan specifically identified a distinction between the skills necessary during the

development phase and those required during production/deployment (Smythe and McMullan, 1975).

Gadeken

Gadeken directed a contractor's study, sponsored by the Defense Systems Management College (DSMC), which identified 16 competencies based on interviews with 56 program managers from the Army, Navy, and Air Force acquisition commands (Gadeken, 1989a; Gadeken, 1989b; Gadeken et al., 1990; DSMC, 1990). "Two groups of program managers were selected for interviews: a group of outstanding performers and a contrasting group of effective (or more typical) performers" (Gadeken, 1989:22b). These interviews were used to generate critical situations involving program managers. These critical situations were later analyzed to identify specific characteristics which were then categorized to make up the preliminary competency model.

The preliminary model was validated through a follow-on survey questionnaire distributed to more than 500 acquisition professionals. Gadeken identified two alternative structures of program manager competencies, which are presented in Tables 12 and 13.

Table 12. Gadeken's Program Management Model (Form 1)

Leadership 1. Sense of Ownership / Mission 2. Long-Term Perspective 3. Assertiveness 4. Managerial Orientation	Problem Solving 10. Proactive Information Gathering 11. Strategic Inquiry 12. Systematic Thinking 13. Interpersonal Assessment
Achievement 5. Focus on Excellence 6. Results Orientation 7. Innovativeness / Initiative 8. Action Oriented 9. Optimizing	Influence 14. Political Awareness 15. Relationship Development 16. Strategic Influence

(DSMC, 1990:E-1)

Table 13. Gadeken's Program Management Model (Form 2)

Managing the External Environment 1. Sense of Ownership / Mission 2. Political Awareness 3. Relationship Development 4. Strategic Influence 5. Interpersonal Assessment 6. Assertiveness Managing the Internal Environment 7. Managerial Orientation 8. Results Orientation 9. Critical Inquiry	Managing for Enhanced Performance 10. Long-Term Perspective 11. Focus on Excellence 12. Innovativeness / Initiative 13. Optimizing 14. Systematic Thinking Proactivity 15. Action Oriented 16. Proactive Information Gathering
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(Gadeken and others, 1990:27)

Best and Kobylarz

The earlier work of the Project Management Institute to establish a Project Management Body of Knowledge was extended to the DoD in an Air Force Institute of Technology graduate thesis by Best and Kobylarz (Best and Kobylarz, 1991). Their scope statement includes a reference to defining, "... the knowledge necessary for a DoD project manager to perform effectively," but their survey was conducted only with program

directors and deputies who are typically the grade of colonel/GM-15, or higher (Best and Kobylarz, 1991:3). Since there are project managers at many levels in DoD, a survey of senior level personnel in one organization type may not provide information that can be generalized to the entire population of project managers.

Their methodology involved ranking the elements of their model. This method provides only relative rankings and provides no basis for assuming that all elements in the model are required. Best and Kobylarz integrated the PMI PMBOK with the requirements of the Defense Systems Management College (DSMC) Program Manager Course to arrive at a Defense Body of Knowledge (DBOK) (Best and Kobylarz, 1991). The elements of these three models are shown in Table 14:

Table 14. PMBOK, DSMC PMC, DBOK Model Comparisons

PMBOK	DSMC PMC	DBOK
Scope	Managerial Development	Strategy & Planning
Time		Management Techniques
Communication & Information		Leadership & Personal Skills
Human Resources	Principles of Program Management	Quality Management
Quality		Risk Management
Risk		
Cost	Cost/Schedule Control	Cost Management
	Contractor Finance	
	Funds Management	
Procurement	Contract Management	Contract Management
	Systems Engineering	Systems Engineering
	Test & Evaluation Management	Test & Evaluation Management
	Logistics	Logistics
	Manufacturing Management	Manufacturing Management
	Software	Software Management
	International Program Management	Aerospace & Defense Management
	Defense Acquisition Policy & Environment	

(Best and Kobylarz, 1991:38)

Acquisition Management Functional Board

The Acquisition Management Functional Board (AMFB) is a high level, joint service board with representation from all three services and from the Defense Systems Management College (DSMC). Its goal was to "obtain a practical set of competencies for the [acquisition management] career field" (AMFB, 1993:1). The board identified competencies it felt required formal education and notes that "the list of validated program manager competencies requiring formal school can now be used to audit existing courses"

(AMFB, 1993:2). Its model is structured by primary activity with a series of competencies under each activity (AMFB, 1993:1). The model grouped a total of 129 competencies into the 12 areas shown in Table 15.

Table 15. AMFB Program Management Model

1. Acquisition Policy	7. Managerial Development
2. Contract Finance	8. Manufacturing Management
3. Contract Management	9. Program Management
4. Cost/Schedule Control	10. Software Management
5. Fiscal Management	11. Systems Engineering
6. Logistics Support	12. Test and Evaluation

(AMFB, 1993)

Summary

The various studies and models presented here show the diversity of methods used to present the competencies required of program managers. Approaches have varied from the consideration of general personality traits and skills to identification of specific knowledge and ability requirements. A significant amount of the research on program management has focused on personality-type characteristics, while specialized areas like cost management have received little attention. Specifically, the area of cost management is addressed only by the AMFB, Best and Kobylarz, PMBOK, and Williams and Currey models in this literature review.

The subjective personality-type competencies like leadership and communication which comprise the majority of this literature are certainly relevant to characterizing general traits of successful program managers, but they do little towards identifying

competencies in specific program management areas (like cost management) in sufficient detail to develop education and training programs.

Of the literature reviewed, the PMBOK and AMFB models provide the greatest level of detail in cost management. However, these models do not identify the perceived value of each cost management competency or any variance among subgroups of the population of interest, Air Force program managers. Without this capability, the research accomplished to date is of limited use in optimizing education and training. A model identifying which individual competencies program managers actually value in their day-to-day activities would provide this type of information. The model developed in Chapter 3 of this thesis was designed to support this purpose.

The method of acquiring cost management competencies is not the focus of this research. However, it is a logical question following the identification of the competencies that program managers rely on. Research by Kerzner identified the perceived relative importance of education and training courses in various aspects of project management. Kerzner and Thamhain both emphasized the importance of acquiring project management skills through experience and special programs developed by individual organizations to meet their individual needs. These studies were included in the literature review to begin to bridge the research of what competencies are valuable, with future research of how the DoD should develop them.

III. Methodology

Overview

A goal of this research was to identify cost management competencies valuable to military program managers. In order to meet this goal, a cost management competency model was developed based on past research. While the model was based on cost management research, the perceptions of program managers in the field were used to evaluate it. Perceptions were gathered through a mail survey of 682 intermediate and senior level military program managers in Air Force Materiel Command. The study also evaluated differences in perceptions among program managers from different organization types, management education backgrounds, primary program activities, and position levels.

The primary focus of this effort was determining the implications the results have for the development and training of program managers in the area of cost management. The remainder of this chapter describes the development of the competency model, the sampling approach, survey instrument development, and the data analysis procedures.

Model Development

Integration of the available material into a concise model required consideration of the relevance and level of indenture of the topic area as well as model efficiency. The goal was to develop a broad-based model reflecting the most important cost management competencies, not an exhaustive list of every tool and technique a program manager might use. The top level structure of the model and its contents is described below.

Model Structure

The structure of the model was based on the cost management section of the Project Management Body of Knowledge (PMBOK) (PMI, 1987). In order to simplify the structure, the fourth PMBOK category (Cost Applications) was eliminated. Important competencies from this section were integrated into other categories. The remaining three categories represent the major steps in the cost management process. The resulting top-level structure of the model was:

Table 16. Model Structure

Cost Management		
Cost Estimating & Forecasting	Cost Budgeting	Cost Controls

Model Elements

The competency topics were synthesized from the contents of the PMBOK and the work of the Acquisition Management Functional Board (AMFB). The PMBOK contains a number of cost management competency areas grouped into the four categories discussed above (PMI, 1987). The AMFB competency model identified a number of competencies in the cost management area and specified a desired level of learning required at each of the three APDP certification levels (AMFB, 1993). The AMFB categorized the level of learning using a six stage taxonomy of learning developed by Bloom (1956). Table 17 illustrates the elements of Bloom's taxonomy, reflecting increasing levels of learning.

Table 17. Bloom's Taxonomy of Learning

Knowledge
Comprehension
Application
Analysis
Synthesis
Evaluation

(Bloom, 1956: 18)

The competency statements in this study's model also considered the level of learning required, focusing on whether the program manager needed to be able to perform a particular task or understand the results of the task. Many cost management topics in the model thus consist of two competencies, a be able to competency and an understand competency. The levels of learning used in this study, while potentially including characteristics of more than one level, are roughly analogous to Bloom's comprehension and application levels.

The competency topic areas were identified through consideration of the elements in the AMFB and PMBOK models. The relevance and level of indenture of the topic areas was considered in an attempt to balance the need to span the range of important cost management topics with the desire for a concise model. Redundant topics or topics less directly tied to cost management were not included. The competencies were organized within the structure defined above. The result is the 47 element model shown in Table 18.

Table 18. Cost Management Competency Model

1.0 Cost Estimating & Forecasting
1.1 Understand current economic conditions and their impact on defense contractors
1.2 Be able to evaluate contractor financial health and viability using financial statements
1.3 Understand the results of financial statement analysis conducted to evaluate contractor financial health
1.4 Be able to apply time value of money techniques such as return on investment (ROI), net present value (NPV), internal rate of return (IRR), and DCF
1.5 Understand the impact of the time value of money on financing and budgeting
1.6 Understand how contractors secure funds to support ongoing projects, plant improvements, and new product development
1.7 Be able to develop a cost estimate using appropriate methods (e.g. parametric, analogy, grass roots)
1.8 Understand cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)
1.9 Be able to use statistical analysis methods such as range analysis and confidence intervals to characterize uncertainty associated with cost
1.10 Understand the implications of uncertainty associated with cost estimates
1.11 Be able to use software tools to support cost estimation, analysis, and presentation
1.12 Understand the products of cost management software tools
1.13 Understand how contractors apply management reserve to respond to contingencies over the duration of a contract
1.14 Be able to apply inflation factors to program costs and funding
1.15 Understand the impact of inflation on program costs and funding
1.16 Understand the impact of production rate and quantity decisions on program cost
1.17 Understand the impact of budget cuts on unit marginal cost
1.18 Understand cost elements such as direct labor, direct materials, general & administrative, profit, and overhead
1.19 Understand ways to characterize costs such as fixed/variable and recurring/non-recurring
1.20 Be able to do break-even analysis using the concepts of fixed and variable costs
1.21 Understand the cost concepts of reasonableness, allocability, and allowability
1.22 Be able to apply learning curve techniques to analyze production costs
1.23 Understand the impact of learning curves on production costs
2.0 Cost Budgeting
2.1 Be able to develop a Work Breakdown Structure (WBS) that describes the entire work effort
2.2 Understand the uses of a WBS for cost management
2.3 Understand the role the organization plays in the Planning, Programming, and Budgeting System (PPBS)
2.4 Understand the congressional budgeting and appropriations processes
2.5 Understand the flow of funds through the expenditure categories of commitments, obligations, and expenditures
2.6 Be able to distribute the cost of work packages across the time horizon to develop a performance measurement baseline (PMB)
2.7 Understand the composition of a PMB
2.8 Be able to evaluate contractor cost accounting and control systems
2.9 Understand contractor cost accounting and control systems
2.10 Be able to select the appropriate contract type for a project
2.11 Understand the cost implications of alternative contract types and pricing mechanisms
2.12 Understand the impact of the political environment on acquisition management
2.13 Be able to generate congressionally required reports such as the SAR
2.14 Understand congressional reporting requirements

3.0 Cost Controls
3.1 Understand the legal and regulatory requirements for cost and schedule control systems such as C/SCSC
3.2 Understand the impact of changes in scope on the cost of defense contracts
3.3 Understand the concept of earned value and methods for calculating it
3.4 Be able to estimate earned value using methods such as weighted milestones and percent complete
3.5 Be able to develop an estimate at completion (EAC) based on the data presented in contractor performance reports
3.6 Understand the utilization of EAC in cost management
3.7 Understand contractor cost reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)
3.8 Be able to analyze contractor reports such as the CPR and CSSR
3.9 Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action
3.10 Be able to develop corrective actions to counter unfavorable program variances

Sampling Approach

An important step in the data collection and analysis process was determining the population and target sample for administering the survey to evaluate the cost management competencies in the model. Careful definition of these groups sets the foundation for developing the survey instruments and interpreting the results.

Population

The cost management competencies required of military program managers was the focus of this research. In particular, the study focused on the perceptions of intermediate and senior level program managers. The effort focused on Air Force Materiel Command (AFMC) which is responsible for most Air Force acquisition programs.

The population and sample groups were identified using the program management certification level required for the position. Each program management position is labeled

with the desired certification level of the program manager who should fill it. Intermediate and senior level program managers fill Level II and Level III positions, respectively. The Acquisition Management Resource Development Team at AFMC (AFMC/XRMA) maintains a database that identifies the person filling each program management position in AFMC. The database contained a total of 816 military program management positions coded Level II or Level III as of February 1994. Since junior program managers are not likely to have a significant experience base upon which to form opinions regarding the competencies in the model, they were excluded from the population. General officers were excluded to avoid impacting their schedules. The following statement identifies the population.

Population: Military personnel below the grade of brigadier general occupying Level II and Level III program management positions in AFMC.

Target Sample

The entire population was contacted with the exception of those not located on military bases. The remaining group, which included 682 of the 816 program managers in the population, became the target sample of this research effort.

Two survey instrument versions were used in order to minimize the time required to complete the survey. Feedback from an instrument pre-test indicated the need to split the questions into two instruments, as discussed below. The first instrument focused on perceived **importance** of the competencies while the second focused on **frequency** of use. Each instrument version was distributed to 341 program managers. Since the research involved analysis of subgroups within the population, a large target sample size

ensured representative coverage of each category (organization type, position certification level, management education, and primary program activity).

To ensure balance between the frequency and importance groups, the Level II and Level III position lists were sorted by military rank and by base of assignment. Half of each list was then assigned to the frequency instrument version and half to the importance version on an alternating basis. This approach resulted in balanced sample groups in terms of rank and location of respondents. The survey was distributed to the following groups in terms of position level and instrument version:

Table 19. Target Sample Size by Instrument Version and Position Level

Group	Version / Level	Number
1	Frequency / Level II	245
2	Frequency / Level III	96
3	Importance / Level II	245
4	Importance / Level III	96

Sample

The survey was distributed by mail to these sample groups. Responses were requested within 4 weeks of the distribution date. A total of 330 program managers returned usable data for a response rate of 48.4%. The responses of these 330 managers constitute the sample for data analysis purposes. The instruments were distributed to four groups of program managers based on the APDP certification level associated with the position and on which of the two instrument versions (Frequency or Importance) they received. Figure 2 shows the number of respondents from each group.

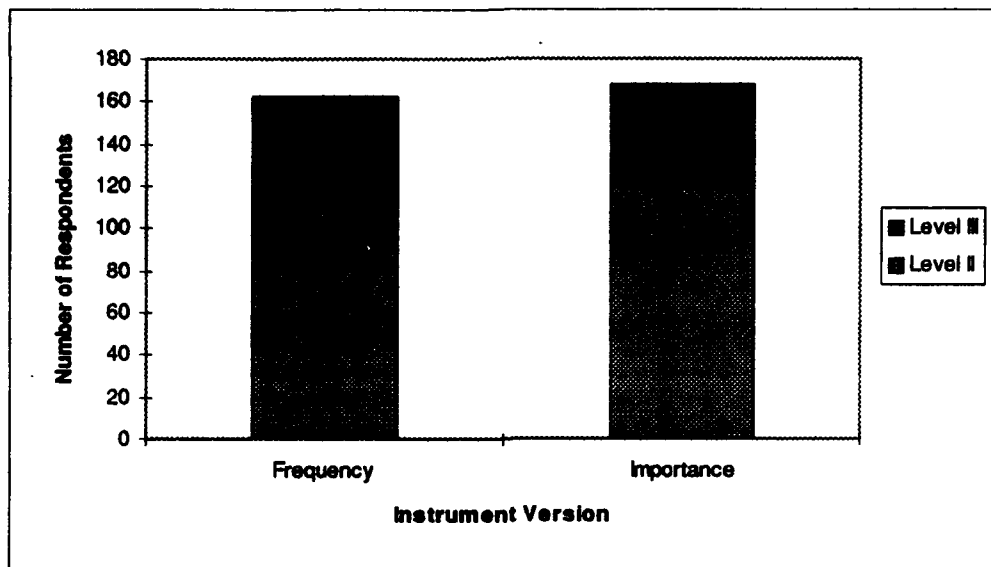


Figure 2. Number of Respondents by Instrument Version

Biographical questions provided demographic information on the respondents.

Figures 3, 4, and 5 show the percentage of respondents from each category.

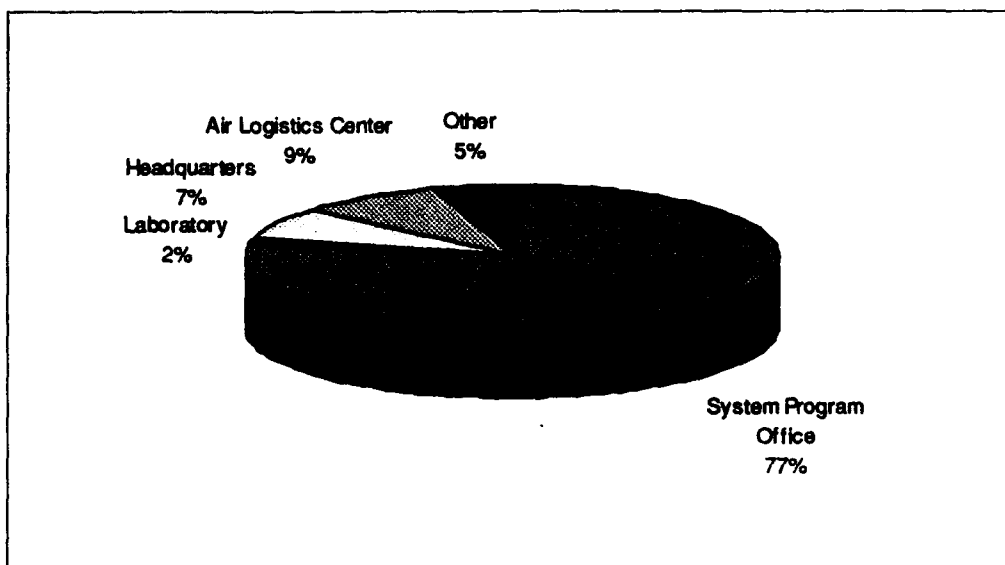


Figure 3. Percentage of Respondents by Organization Type

Figure 3 highlights the concentration of acquisition positions in the SPOs. Approximately 5% of the respondents did not fit into one of the common organization types provided in the instruments.

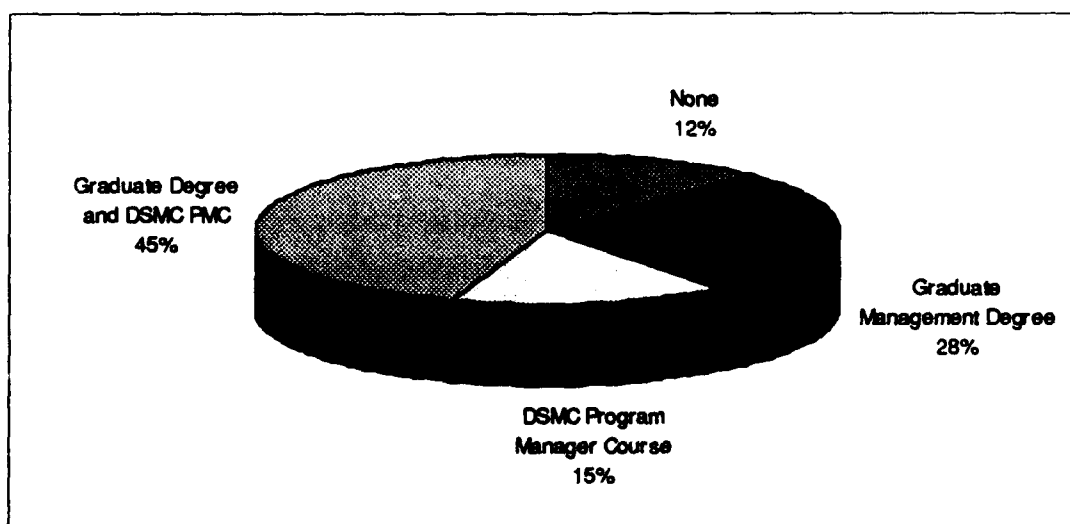


Figure 4. Percentage of Respondents by Management Education

The largest group of respondents had completed both a graduate management degree and the DSMC Program Manager Course. In all, 88% of respondents had completed some form of graduate management education.

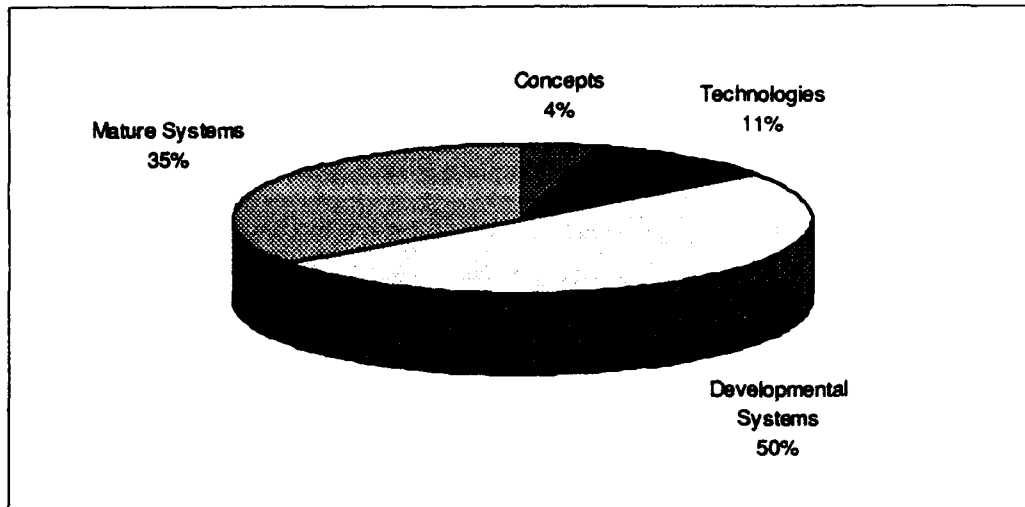


Figure 5. Percentage of Respondents by Primary Program Activity

Consistent with the large number of respondents from SPOs, most respondents work with developmental and mature systems. Only 15% of the respondents work with the early stages of the process dealing with concepts and technologies.

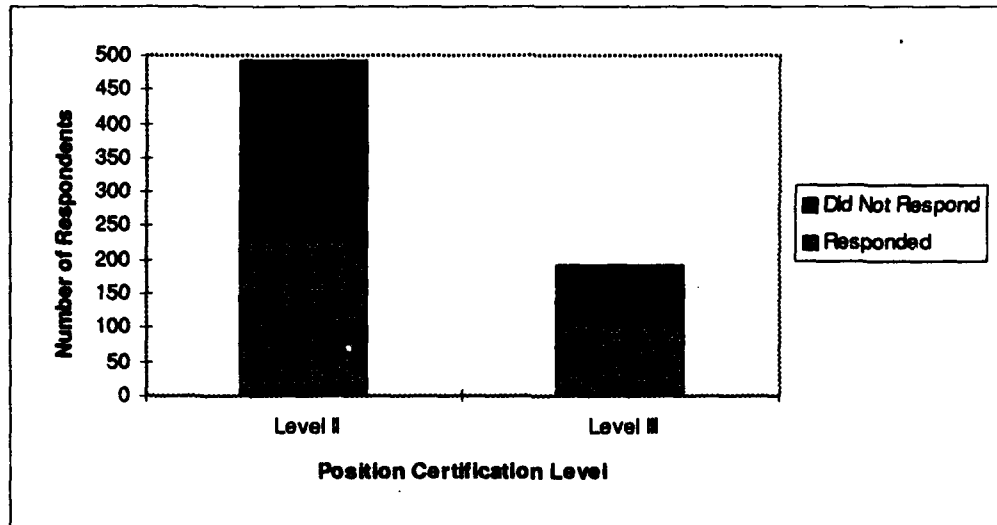


Figure 6. Number of Respondents by Position Certification Level

The sample reflects the larger number of Level II program managers in the population. Approximately two-thirds of the respondents were serving in Level II program management positions. Intermediate level program managers thus had a greater contribution to overall results than senior level managers. Figure 6 also shows that the response rates for Level II and Level III program managers were comparable (46.3 % and 53.6 % respectively).

Instrument Development

The first step in the development of the survey instruments was to determine how to assess the value of each competency. Once this was accomplished, the response scales and question structure could be specified. The instruments were structured to be both valid and reliable. A pre-test provided feedback on the draft instrument.

Frequency and Importance

The primary attribute of interest in this research was the value of each competency. Quantifying value is a difficult task. One approach is to solicit only the frequency of use of each competency. Unfortunately, there could be competencies that, although rarely used, are absolutely critical to the success of the program. For example, a program might only develop a work breakdown structure (WBS) once, but the WBS is the base upon which the entire program is built. Therefore, frequency alone is not enough.

The importance of a competency is another indicator of its value. This measure accounts for the value of competencies such as WBS development. Although infrequently used, such competencies could be extremely important. The two measures, frequency and importance, were integrated through use of a decision rule to assess the value of each competency.

Response Scales

The primary data in this research was the reported frequency of use and perceived importance of competencies scored on descriptive ordinal scales. The critical decisions in defining a scale include how many responses to include and what descriptors to use.

Meister cites studies noting that:

... there is apparently no gain in reliability if one increases the number of categories from 5 to 9, but reliability drops with 3 (too gross) or more than 7 (too fine) ... There appears to be little utility in having more than 5 scale categories. (Meister, 1985:326)

A choice must be made regarding how extreme the ends of the scale should be (Meister, 1985:382). This choice has a direct impact on the number of categories in the

scale. For example, in developing a scale for frequency one could use very frequently/infrequently or always/never as the extremes, thus leaving only three other alternatives. Neither of the response scales used for this research included absolute values, so five value response scales were sufficient. A sixth response, don't know, accommodated respondents unfamiliar with particular competencies.

Frequency

The frequency response scale for this effort employed a series of time intervals between uses of the competency. Table 20 presents the response scale.

Table 20. Frequency Response Scale

1	2	3	4	5	6
Annually or less	Quarterly	Monthly	Weekly	Daily	Don't Know

Importance

The importance response scale was a series of ordinal descriptors reflecting incremental increases in perceived importance. Table 21 shows the scale used in the instruments (Meister, 1985:382-9).

Table 21. Importance Response Scale

1	2	3	4	5	6
Not Important	Slightly Important	Important	Very Important	Extremely Important	Don't Know

Pre-Test Instrument Structure

A survey instrument was developed using the competencies and response scales described above. This instrument was pre-tested on a group of program management students and modified based on their feedback. The pre-test instrument contained three sections. The first section requested biographical information regarding the following areas:

- Civilian or Military Status
- Organization Type
 - System Program Office, Headquarters, Logistics Center, Laboratory
- Management Education
 - Completion of DSMC Program Manager Course or a Graduate Management Degree
- Primary Activity / Program Phase
 - Concepts, Technologies, Developmental Systems, Mature Systems

The second section of the pre-test survey evaluated perceived importance of each competency in the model based on a five-point scale of suitable ordinal descriptors. The third section evaluated frequency of use of each competency on a similar five-point scale. The instrument contained a total of 100 questions.

Pre-Test

The initial instrument was pre-tested on a group of 12 graduate program management students. Specific areas of interest for the pre-test were the time to complete the instrument as well as clarity of the instructions, response scales, and competency statements. Written comments on the instrument were solicited via open-ended questions

on a feedback sheet provided after the pre-test respondents completed the survey (Meister, 1985:387).

The pre-test resulted in significant changes to the instrument. The average time to complete the survey was 21.6 minutes. The respondents were asked to mark the computer data sheet at five minute increments throughout the pre-test. This information was used to determine the question response rate (Table 22).

Table 22. Pre-Test Question Response Rate

Time (Minutes)	Average Questions Completed
10	45
15	67
20	89
25	98

There were several verbal and six written comments that the instrument was too long. Although the instrument only took 22 minutes on average to complete, with 100 questions, it was perceived to be too long. Based on this feedback, the instrument was divided into the frequency and importance versions mentioned above. Since each respondent addressed either frequency or importance instead of both, this essentially halved the number of questions for the final instrument. Surveying both civilian and military employees for this research was administratively prohibitive. As a result, the survey focused on military personnel and the question regarding civilian or military status was deleted.

Seven of the twelve respondents missed the change in scales from importance to frequency. The final instrument included large, bold section headings to clearly delineate all transitions. Six respondents suggested that they needed a choice between annually and monthly on the frequency response scale. The modified frequency scale combined two terms and added a quarterly option as indicated in Table 23.

Table 23. Frequency Response Scale Comparison

Initial Instrument	Final Instrument
Less than once per year	Annually or less
Annually	Quarterly
Monthly	Monthly
Weekly	Weekly
Daily	Daily
	Don't Know

The final instrument thus consisted of two versions, frequency and importance. Each version contained 56 questions. Both instruments are provided for reference in Appendix A.

Survey Methods

There are a variety of approaches to developing and distributing mail surveys to achieve a high response rate. The key is to develop an integrated cover letter, instrument, and distribution process that motivates the respondent to complete the instrument (Dillman, 1978). Several actions were taken to elicit a credible response rate for this survey.

The cover letter accompanying the survey instruments in this effort incorporated several recommendations from the literature designed to motivate the respondents. The letter identified the research with a known organization, the Air Force staff at the Pentagon. Mr. Teddy Houston, the Associate Director of Acquisition for Career Management under the Assistant Secretary of the Air Force (Acquisition), signed the cover letter. Mr. Houston is responsible for acquisition professional development in the Air Force. His letter stressed the value of the research in improving training and education programs; noted that respondents were selected based on their experience, education, and training; and requested their support (Dillman, 1978:13,18,162-69). A time-to-complete estimate was noted in the cover letter emphasizing the minimal amount of time required (Dillman, 1978:14-15,18,54-55). All respondents were assured anonymity and assured that no adverse action would be taken for not responding (Dillman, 1978:170; Meister, 1985:384). A copy of this cover letter is provided with the survey instruments in Appendix A.

The questions were grouped into four sections: biographical, frequency or importance, reliability checks, and open-ended questions. The biographical questions formed the basis for subgroup analysis. Grouping the frequency and importance questions allowed placement of a single scale at the top of the page that could be applied to all questions on that page. The final section asked if any significant competencies were omitted, asked respondents to identify their most important and most frequently used competencies, and provided space for any additional comments.

Validity

Validity and reliability are concepts that reflect the quality and performance of an instrument. Validity is, "... the extent to which a test measures what we actually wish to measure" (Emory and Cooper, 1991:179). External validity refers to the generalizability of the results, while internal validity refers to ability to measure constructs (Emory and Cooper, 1991:179-80).

Internal Validity

This effort examined two constructs: the perceived importance and frequency of usage of a set of cost management competencies. Choice of suitable descriptor scales is one way to improve internal validity. A good descriptor scale directly addresses the constructs of interest and adequately reflects variation in those constructs.

Confusion regarding the intended meaning of the competency could be a source of error. Questions may be too vague or too precise, and researchers must consider how much knowledge they assume respondents have (Dillman, 1978:99-101, 112). One way to structure the instruments was to describe each competency in a single sentence. The limitation of this approach is that it was likely that some statements would not be understood by the respondents.

An alternative approach is to provide detailed competency descriptions in the question or at the end of the instrument. However, if a respondent required a definition of the competency, it is not likely that it is important to or frequently used by that manager. The additional material would have made the instrument longer and more complex.

The chosen approach used simple and brief competency statements. Examples of specific methods within a competency were provided to clarify the topic. For example, the cost estimation competencies mention the parametric, analogy, and grass roots methods. To accommodate those who did not understand a particular statement or were not familiar with the competency, both the frequency and importance response scales included a Don't Know option.

Spyridakis discusses eight threats to internal validity (1992:612-13). Two of these were particularly relevant to this research. The first was bias resulting from the sample selection process (Spyridakis, 1992:612). The use of two survey instruments versions mandated an effort to ensure that the sample groups completing each version were similar. If the two groups did not reflect the same population, the resulting data would be of questionable value.

The two instrument versions differed in the aspect of each competency that they measured. One instrument focused on perceived importance, while the other focused on frequency of use. The solution to the problem was for each group to evaluate five competencies in terms of the alternate aspect. Thus, those completing the importance version of the instrument evaluated all 47 competencies in terms of importance and five in terms of frequency of use. The responses for those five questions were then compared to the same five questions for the group completing the frequency version of the instrument. All ten questions compare the same two groups resulting in ten independent assessments of equality between the groups.

A Kruskal-Wallis test on each question determined whether the population distributions were identical. The p-values presented in Table 24 represent the smallest level of significance that would result in rejection of the hypothesis that the response distributions are the same (Devore, 1991:315).

Table 24. Group Kruskal-Wallis Tests

Question	Frequency	Importance
1	.8958	.0016
2	.7994	.0573
3	.9564	.2060
4	.1289	.0174
5	.0099	.0013

In four out of ten cases, the results indicate that the two sample groups reflect different populations ($\alpha = .05$). This provides some indication that the groups differed. However, no obvious reason for the differences was evident. The change in question format from frequency to importance (or the reverse) may have contributed. This area of concern was noted in the pre-test. Although the instrument was revised to highlight the change, the transition may still have been confusing. The p-values appear to be lower for the group focusing on perceived importance. This could indicate that the transition from importance to frequency may have caused more difficulty.

Another way to illustrate the potential differences between the frequency and importance groups is to look at the ranking of the five competencies used for comparison. The full set of 47 competencies can be ranked based on the proportion answering four or five on the response scales. The response data for the other group can then be substituted

for the five competencies used for comparison. Since the response data may differ, the relative rank of these competencies within the full set of 47 may change. Appendix G illustrates the change in rank that would result if the data from the alternate group were used. In eight of the ten cases, the shift is three places or less.

The second threat is that the subjects' expectations will affect their responses (Spyridakis, 1992:613). The survey package did not provide any significant details about the research that might bias responses. The cover letter accompanying the package did not list any specific goals for the research other than exploration of this area (Dillman, 1978: 167). A similar problem is that respondents' results may be biased if they feel pressure to respond in a certain way (Emory and Cooper, 1991:178). This effect was minimized by assuring anonymity to all respondents and not mandating participation.

External Validity

External validity deals with generalizability. This research effort involved a variety of program managers within AFMC. However, the target sample excluded program managers who were not located on military bases. For example, program managers serving in Defense Plant Representative Offices were not contacted. Those not contacted constituted approximately 16% of the population. It is possible that this omission induced some bias in the results if managers in these positions value different cost management competencies than those in the target sample. However, approximately 84% of the population received a version of the survey instrument, which provides a substantial representation of the population across a variety of organization types.

Reliability

Reliability refers to consistency in the results of an instrument (Emory and Cooper, 1991:185). Evaluation of instrument reliability often involves repeated testing and comparison of results (Emory and Cooper, 1991:180). Due to the senior level of portions of the population and the necessity to limit the impact of the research on Air Force personnel, it was not practical to retest. One competency question in each instrument version was duplicated allowing a measure of internal consistency for each respondent. Spearman's rank correlation was used to evaluate correlation in the paired data. Table 25 provides the values for Spearman's rho.

Table 25. Internal Consistency Correlation

	Frequency Instrument	Importance Instrument
Correlation	.7281	.5672

These values are somewhat lower than expected, but may have resulted from changing perceptions as the respondent completed the instrument. Another method for measuring internal consistency is to evaluate the magnitude of the difference in the two answers for each respondent. Table 26 provides a frequency distribution for these differences.

Table 26. Internal Consistency Differences

Difference	Frequency Instrument	Importance Instrument
0	69.0 %	46.4 %
1	21.9 %	42.8 %
2	9.0 %	9.0 %
3	0 %	1.8 %

Less than 11% of the respondents differed by more than 1. Given the subjective nature of the response scales, these results provide a fairly good indication that the respondents were internally consistent.

Data Analysis

Approach

The data analysis approach is dependent upon the structure of the response data. Data analysis for this study involved two primary tasks. Answering the first research question required evaluation of the proposed model using data from the entire sample. This evaluation was accomplished by considering both frequency and importance rankings individually. A decision rule, discussed below, merged the two concepts into a single measure of value for the competencies. The second research question required analyzing differences in the responses among subgroups of the population. The Kruskal-Wallis test was used to identify differences in the responses between those from different organization types, program activities, position level, and management education background.

Response Data Structure

Respondents marked their answers on a machine readable form. The forms were then machine scanned, producing a computer file of the response data, which was used for subsequent data analysis. It was important to consider whether data from these scales was ordinal or interval. Ordinal data has, "Order but no distance or unique origin" (Emory, 1991:172). Interval data, on the other hand, has order and a constant distance between successive points on the scale. Ordinal data precludes using statistical procedures such as determination of mean and variance, regression analysis, and standard analysis of variance. These procedures require at least interval level data (Conover, 1980:66). Meister presents results from a 1976 study by Dyer that studied frequency descriptor lists (Meister, 1985:383). The results indicate that data points on the frequency descriptor scale studied were not evenly spaced and therefore represented ordinal data at best.

The importance scale was a list of descriptors. There was no basis for an assumption of equal spacing between options, so the data was considered ordinal. The Don't Know option cannot be easily ordered with the other responses. As a result, the proportion of respondents answering Don't Know was noted for each competency, but these responses were not included in the analysis. Data analysis with ordinal data uses the median as a measure of central tendency. Conover discusses tools such as the Kruskal-Wallis test which allow non-parametric analysis of variance (Conover, 1980). The Kruskal-Wallis test is discussed in the data analysis section .

Research Question 1 Analysis

The model was first evaluated by analyzing the frequency and importance data individually. The median response value for each competency was calculated, as was the proportion of respondents answering four or five. In terms of frequency of use this corresponds to using the competency Weekly or Daily. For the importance instrument, the values indicated that the competency was considered Very Important or Extremely Important. The competencies were then ranked by this proportion to highlight the most important and most frequently used competencies.

The frequency and importance data were then combined by applying a decision rule to the data. The decision rule was a subjective effort to integrate frequency and importance into a single measure reflecting the value of each competency. Frequency and importance were weighted equally in the decision rule.

Decision Rule: Any competency whose median values for importance and frequency sum to six (6) or greater is considered valuable.

The result of applying the decision rule was a list of competencies that were considered valuable by program managers in the field.

Research Question 2 Analysis

The second data analysis process was variance analysis. The purpose of this analysis was to evaluate differences in the competencies required of program managers as a function of organization type, program management education, primary program activity, and position level. The elements within each of these groups are:

1. **Organization Type**
 - System Program Office, Headquarters, Logistics Center, Laboratory
2. **Management Education**
 - Completion of DSMC Program Manager Course and/or a Graduate Management Degree
3. **Primary Activity / Program Phase**
 - Concepts, Technologies, Developmental Systems, Mature Systems
4. **Position Certification Level**
 - Level II, Level III

Kruskal-Wallis

The subgroup analysis process identified differences in the perceived frequency and importance of each competency separately using the Kruskal-Wallis test for non-parametric analysis of variance. As described in Conover (1980:229-37), this test allows for comparison of sets of ordinal data.

The hypotheses for a Kruskal-Wallis test are:

H₀: All of the k population distribution functions are identical

H_a: The k populations do not have identical distributions

Rejection of the null hypothesis indicates that the subgroup responses were not identically distributed. This indicates that the subgroups did not find the competency in question equally important or that they did not use it equally frequently. The populations for the Kruskal-Wallis test were the sample subgroups identified above.

The Kruskal-Wallis test has three primary assumptions (Conover, 1980:230):

1. All samples are random samples
2. Independence within and between samples
3. The measurement scale is at least ordinal

The response data is ordinal as discussed above. Consideration of a single competency, only in terms of frequency or importance, results in independence between

and within the samples. The sample assignment process described above should have resulted in balanced samples, although the assignment was not purely random. In addition, those not on military bases were excluded as discussed above. Statistical assessments were made as part of the analysis, but the potential impact of the limitations should be noted. Although a level of significance of .05 was used to accept or reject the null hypothesis, p-values for the Kruskal-Wallis tests are provided in appendices permitting the user to assess the significance of the result if desired.

Summary

The goal of this research was to improve the development and training of program managers in the area of cost management. Cost management models developed by the Project Management Institute and the Acquisition Management Functional Board formed the foundation of the cost management competency model developed in this study. Two survey instruments, examining the perceived importance and frequency of use of these competencies, were each distributed to 341 intermediate and senior level program managers. Data analysis procedures allow specification of the valuable competencies and analysis of variations among program managers with different management education backgrounds, organization types, primary program activities, and position certification levels. Chapter IV presents the results obtained by implementing this methodology.

IV. Findings and Analysis

Introduction

This study focused on two major research objectives: identifying valuable cost management competencies and identifying differences in responses among subgroups of the population. The perceptions of 330 program managers were used to answer those questions. The remainder of this chapter answers each research question, in turn, and concludes with a discussion of additional competency areas identified by the respondents.

Research Question 1

Answering the first research question involved analysis of the frequency and importance data individually. The data was then analyzed collectively through the use of a decision rule which integrated frequency and importance responses into a single measure of value.

Frequency

The frequency data was ranked based on the percentage of respondents using each competency Daily or Weekly. Tables 27 and 28 present the 10 most frequently and 10 least frequently used competencies on this basis.

Table 27. Most Frequently Used Competencies

Competency	Percent Using Daily or Weekly
Understand the impact of the political environment on acquisition management	46.2
Understand the flow of funds through the expenditure categories of commitments, obligations, and expenditures	45.9
Understand the impact of changes in scope on the cost of defense contracts	42.3
Understand the role the organization plays in the Planning, Programming, and Budgeting System (PPBS)	37.8
Understand current economic conditions and their impact on defense contractors	35.1
Understand the congressional budgeting and appropriations process	35.0
Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action	28.1
Understand cost elements such as direct labor, direct materials, general & administrative, profit, and overhead	27.8
Understand ways to characterize costs such as fixed/variable and recurring/non-recurring	27.6
Understand the impact of inflation on program costs and funding	25.4

Table 28. Least Frequently Used Competencies

Competency	Percent Using Daily or Weekly
Be able to evaluate contractor financial health and viability using financial statements	4.5
Be able to analyze contractor reports such as the CPR and CSSR	3.8
Be able to do break-even analysis using the concepts of fixed and variable costs	3.4
Be able to distribute the cost of work packages across the time horizon to develop a performance measurement baseline	3.4
Be able to evaluate contractor cost accounting and control systems	2.6
Be able to apply time value of money techniques such as return on investment (ROI), net present value (NPV), internal rate of return (IRR), and declining cash flows (DCF)	2.0
Be able to apply learning curve techniques to analyze production costs	2.0
Be able to generate congressionally required reports such as the SAR	2.0
Be able to develop a Work Breakdown Structure (WBS) that describes the entire work effort	1.9
Be able to use statistical analysis methods such as range analysis and confidence intervals to characterize uncertainty associated with cost	0

It is interesting to note that 9 of the 10 most frequently used competencies are understand competencies, while all of the least frequently used competencies are be able to competencies. The single be able to competency in the most frequently used 10 deals with analyzing contractor-recommended corrective actions. This indicates that program managers must understand the results of analysis and other program management issues, but are rarely required to complete those actions themselves.

Importance

The importance data was ranked based on the proportion of respondents who indicated the competency was Very Important or Extremely Important. Tables 29 and 30 present the 10 most important and 10 least important competencies based on this ranking.

Table 29. Most Important Competencies

Competency	Percent Rating Very or Extremely Important
Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action	85.1
Understand the cost implications of alternative contract types and pricing mechanisms	81.5
Understand the impact of changes in scope on the cost of defense contracts	81.5
Understand the role the organization plays in the Planning, Programming, and Budgeting System (PPBS)	80.9
Be able to develop corrective actions to counter unfavorable program variances	79.8
Understand cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)	79.6
Understand the impact of production rate and quantity decisions on program cost	79.6
Understand the flow of funds through the expenditure categories of commitments, obligations, and expenditures	78.5
Understand cost elements such as direct labor, direct materials, general & administrative, profit, and overhead	75.6
Understand contractor cost reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)	73.9

Table 30. Least Important Competencies

Competency	Percent Rating Very or Extremely Important
Understand how contractors secure funds to support ongoing projects, plant improvements and new product development	33.9
Be able to develop an estimate at completion (EAC) based on data presented in contractor performance reports	32.4
Be able to apply inflation factors to program costs and funding	32.1
Be able to do break-even analysis using the concepts of fixed and variable costs	28.5
Be able to distribute the cost of work packages across the time horizon to develop a performance measurement baseline	28.2
Be able to use statistical analysis methods such as range analysis and confidence intervals to characterize uncertainty associated with cost	25.9
Be able to apply learning curve techniques to analyze production costs	25.8
Be able to estimate earned value using methods such as weighted milestone and percent complete	24.3
Be able to apply time value of money techniques such as return on investment (ROI), net present value (NPV), internal rate of return (IRR), and declining cash flows (DCF)	22.2
Be able to use software tools to support cost estimation, analysis, and presentation	22.0

The pattern for the importance data is similar to that of the frequency data. While eight of the ten most important competencies required understanding, nine of the ten least important competencies were be able to competencies.

Decision Rule

A decision rule provided a means for combining the concepts of frequency and importance into a single measure of value for the competencies. The decision rule considered the competency valuable if the sum of its median values for frequency and importance totaled six (6) or greater. Using this rule, 29 of the 47 competencies were considered valuable. A complete list of the median sums is provided in Appendix D. Tables 31 through 33 group the valuable competencies into three tiers by the sum of their medians. Tier one competencies had a median sum of 8, tier two had a sum of 7, and tier three a sum of six. Higher median sums indicates competencies that are both important and frequently used and are thus more valuable.

Table 31. Tier One Competencies (Most Valuable)

Competency
Understand the role the organization plays in the Planning, Programming, and Budgeting System (PPBS)
Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action

Table 32. Tier Two Competencies

Competency
Understand current economic conditions and their impact on defense contractors
Understand cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)
Understand the implications of uncertainty associated with cost estimates
Understand how contractors apply management reserve to respond to contingencies over the duration of a contract
Understand cost elements such as direct labor, direct materials, general & administrative, profit, and overhead
Understand ways to characterize costs such as fixed/variable and recurring/non-recurring
Understand the uses of a WBS for cost management
Understand the congressional budgeting and appropriations process
Understand the flow of funds through the expenditure categories of commitments, obligations, and expenditures
Understand the impact of the political environment on acquisition management
Understand the impact of changes in scope on the cost of defense contracts
Understand the utilization of EAC in cost management
Understand contractor reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)
Be able to analyze contractor reports such as the CPR and CSSR
Be able to develop corrective actions to counter unfavorable program variances

Table 33. Tier Three Competencies

Competency
Understand the products of cost management software tools
Understand the impact of inflation on program costs and funding
Understand the impact of production quantity and rate decisions on program cost
Understand the impact of budget cuts on unit marginal cost
Understand the cost concepts of reasonableness, allocability, and allowability
Understand the impact of learning curves on production costs
Understand the composition of a Performance Measurement Baseline (PMB)
Understand contractor cost accounting and control systems
Understand the cost implications of alternative contract types and pricing mechanisms
Understand congressional reporting requirements
Understand the legal and regulatory requirements for cost and schedule control systems such as C/SCSC
Understand the concept of earned value and methods for calculating it

Don't Know

A Don't Know option was provided on both the frequency and importance response scales to accommodate those who did not understand, or were not familiar with, the competency. Don't Know responses were excluded from the data analysis because they could not be ordered in the response scales. Appendix E illustrates the percentage of respondents that answered Don't Know. No more than 10% of the responses for any individual competency were Don't Know. The percentage of Don't Know responses averaged .09 % for the importance instrument and 3.4 % for the frequency instrument. This indicates the vast majority of respondents understood the competency statements in the model. The difference in Don't Know response averages between the two instrument versions could indicate that respondents had a more difficult time conceptualizing the competency in terms of frequency of use.

Model Categories

The cost management competency model developed for this research contained three major areas: cost estimating, cost budgeting, and cost control. Figure 7 illustrates the percent of the competencies in each category that were considered valuable per the decision rule.

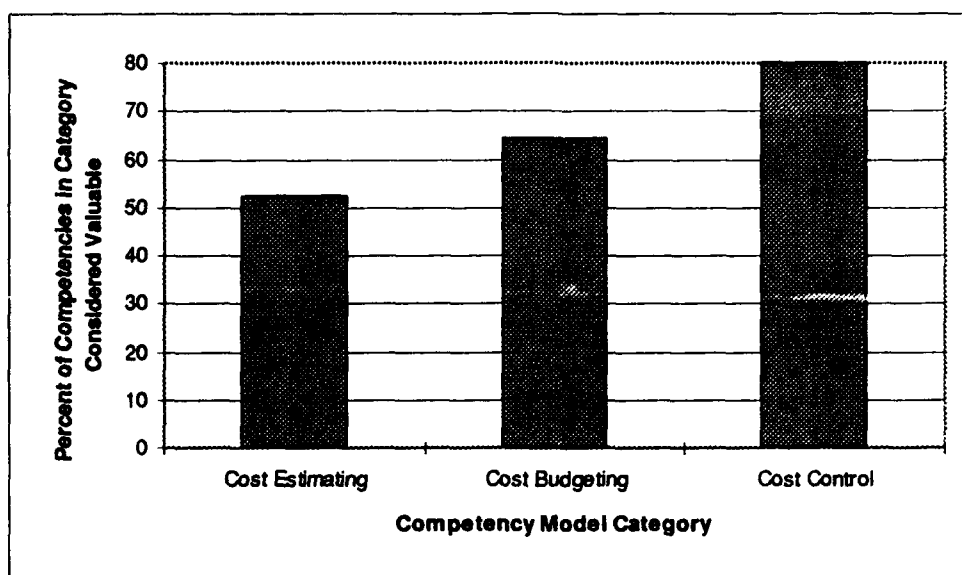


Figure 7. Valuable Competencies by Model Category

This data indicates that more of the cost control competencies were considered valuable by program managers according to the decision rule. The decision rule weighted importance and frequency equally. However, the proportions answering four or five were higher for the importance instrument. This could result in some bias of the decision rule results in favor of importance. Since cost control activities are probably conducted more frequently than estimation or budgeting, a revised decision rule balancing the response data might make the cost control category appear even more valuable.

Comprehension vs. Application

The cost management model developed for this study includes competencies at both the comprehension and application levels of learning. There are 18 Be able to competencies and 29 Understand competencies in the full model. Figure 8 illustrates the level of learning required for the valuable competencies.

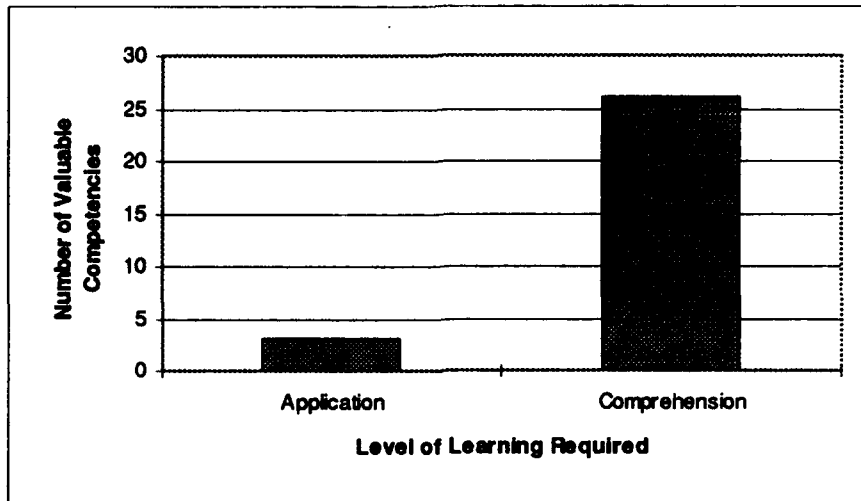


Figure 8. Level of Learning Required for Valuable Competencies

This result clearly indicates that more of the comprehension competencies were found to be valuable. The analysis indicated that 90% of the comprehension competencies were valuable while only 17% of the application competencies were valuable.

Research Question 2

The second research question analyzed differences in the responses between subgroups of the sample. The Kruskal-Wallis test for non-parametric analysis of variance was used to compare the response distributions of the subgroups. A detailed discussion of the individual groups follows an overview of the Kruskal-Wallis results.

Results Overview

The analysis process for each group consisted of 98 Kruskal-Wallis tests. The tests compared the subgroup response distributions for each of the 47 competencies on the

basis of frequency of use or perceived importance. For example, a single test might evaluate whether program managers with four different levels of management education consider a given competency equally important. The test compares the response distributions for all the subgroups. The hypothesis that all the subgroups share the same response distribution can be rejected if even one subgroup has a different response distribution. Appendix F contains the p-values for these tests, which represent the smallest level of significance that would result in rejection of the hypothesis that the response distributions are the same (Devore, 1991:315). The results can be summarized by looking at the number of tests that identified subgroup response differences. Figure 9 shows the number of competencies with response distribution differences for each demographic group and for both instrument versions.

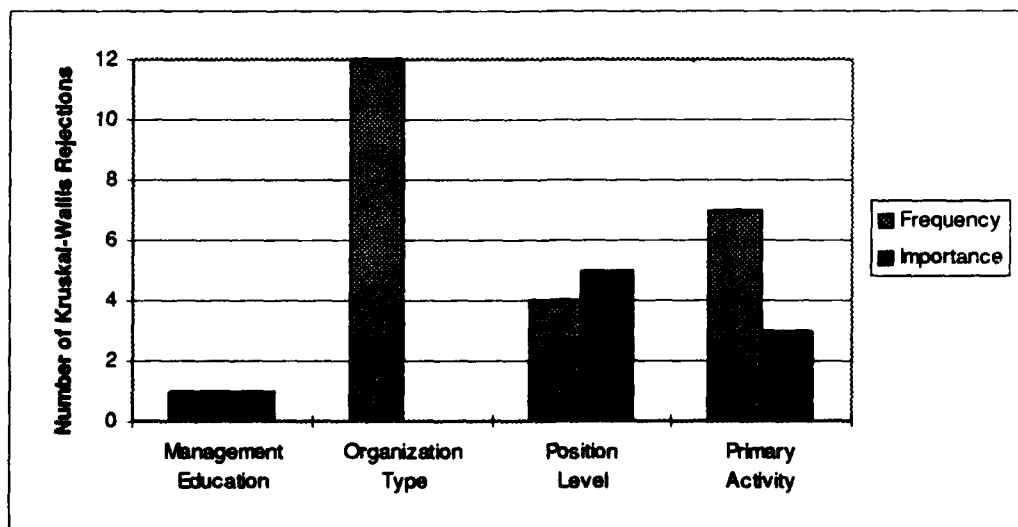


Figure 9. Number of Kruskal-Wallis Rejections

It is interesting to note that those with different management education backgrounds responded differently to only one of 47 competencies on each instrument version. Roughly 10% of the Kruskal-Wallis tests identified variations in the perceived importance or frequency of use of competencies on the basis of position certification level or primary program activity. Comparison of the response groups from different organization types revealed an interesting dichotomy. While 12 competencies showed different frequency of use, none differed with respect to perceived importance.

As noted in the methodology chapter, it was not possible to identify the number of respondents in each subgroup prior to distribution of the survey instruments. Tables 34 through 37 show the number of respondents in the subgroups when stratified based on management education, organization type, primary program activity, and position certification level.

Table 34. Management Education Respondents

Instrument	None	Graduate Degree	DSMC PMC	Both	Total
Frequency	17	41	25	70	153
Importance	21	46	23	70	160

Table 35. Organization Type Respondents

Instrument	SPO	Lab	HQ	ALC	Other	Total
Frequency	123	1	11	13	7	155
Importance	119	5	12	14	9	159

Table 36. Primary Program Activity Respondents

Instrument	Concepts	Technologies	Developmental Systems	Mature Systems	Total
Frequency	5	12	77	46	140
Importance	7	19	66	54	146

Table 37. Position Level Respondents

Instrument	Level II	Level III	Total
Frequency	108	54	162
Importance	119	49	168

The number of respondents assigned to specific subgroups varied significantly. The sample size in several of these subgroups was quite small. In some cases, there may only be a few members in the entire population. While it is still possible to conduct the Kruskal-Wallis test, the small sample sizes for those subgroups may not adequately represent the population. In these cases, the small sample can bias the Kruskal-Wallis test. The subgroup response distributions could falsely appear equal or an actual difference might not be identified.

Management Education

There were only two competencies for which the perceived importance or frequency of use varied with different education backgrounds. The fact that only two differences were identified in 98 tests (47 frequency and 47 importance) indicates that the level of management education did not significantly impact either the perceived importance or frequency of use of the competencies in the model. This contradicts the hypothesis that those with more management education might find more or different

competencies valuable because of their increased exposure to management techniques and tools. Tables 38 and 39 show the rejected competencies and the median values for the subgroups.

Table 38. Frequency Differences Based on Management Education

Competency	Subgroup Median			
	None	Graduate Degree	DSMC PMC	Both
Understand cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)	Quarterly	Quarterly	Monthly	Monthly

Table 39. Importance Differences Based on Management Education

Competency	Subgroup Median			
	None	Graduate Degree	DSMC PMC	Both
Understand the impact of learning curves on production costs	Very Important	Important	Very Important	Very Important

Organization Type

As discussed above, some subgroups had small sample sizes. In terms of organization type, both the *laboratory* and *other* subgroups had sample sizes of less than 10 for both instruments. Due to the small sample size in these two subgroups, and the difficulty in drawing meaningful conclusions about the *other* subgroup, they were excluded from the organization type Kruskal-Wallis tests.

There was an interesting disparity between the two instrument versions in the number of differences identified based on organization type. The results indicated that for

12 competencies, the frequency of use distribution was not the same for all subgroups.

However, no differences were identified in the perceived importance of the competencies.

This indicates that while the competencies are considered equally important in all organizations, they are not equally frequently used. Table 40 shows the competencies not having the same distribution.

Table 40. Frequency Differences Based On Organization Type

Competency	Subgroup Median		
	SPO	HQ	ALC
Understand current economic conditions and their impact on defense contractors	Monthly	Quarterly	Quarterly
Be able to apply time value of money techniques such as return on investment (ROI), net present value (NPV), internal rate of return (IRR), and declining cash flows (DCF)	Annually or Less	Annually or Less	Annually or Less / Quarterly
Understand the impact of inflation on program costs and funding	Quarterly	Monthly	Weekly
Understand the impact of production rate and quantity decisions on program cost	Quarterly	Quarterly	Weekly
Understand cost elements such as direct labor, direct materials, general & administrative, profit, and overhead	Monthly	Quarterly	Weekly
Understand ways to characterize costs such as fixed/variable and recurring/non-recurring	Monthly	Monthly	Weekly
Be able to apply learning curve techniques to analyze production costs	Annually or Less	Annually or Less	Quarterly
Be able to select the appropriate contract type for a project	Annually or Less	Annually or Less	Quarterly
Understand the utilization of EAC in cost management	Monthly	Quarterly	Quarterly
Understand contractor cost reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)	Monthly	Quarterly	Quarterly
Be able to analyze contractor reports such as the CPR and CSSR	Monthly	Annually or Less / Quarterly	Quarterly
Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action	Monthly	Annually or Less / Quarterly	Monthly

The results indicate that program managers in SPOs are more frequently called upon to use five of the competencies. The SPOs involvement in development efforts could account for their increased interest in economic conditions and their impact on defense contractors. Along the same lines, SPO efforts in the early phases of program development are more likely to include cost based contracts which require analysis of contractor cost and schedule status data, and evaluation of recommended corrective actions.

The ALCs use several of the competencies more frequently than SPOs or headquarters. ALCs are likely to deal with a large number of contracts to procure a variety of spare parts and support equipment for systems. This could account for their increased frequency of selecting a proper contract type, characterizing costs, and considering cost elements. Increased consideration of production rates and quantities could be related to the ALCs involvement in production contracts. The longer time horizon ALCs face could account for their increased consideration of economic conditions such as inflation.

The headquarters group appears to use many of the competencies in Table 38 less frequently than the other two groups. Although classified as program managers, personnel in headquarters are not likely to be involved in the day-to-day planning and management of programs. Therefore, it is not surprising that they do not frequently use cost management competencies.

Primary Program Activity

The primary program activity is comparable to the program phase. Not all programs complete the normal program phases. A laboratory program, for example, may consist of concept analysis alone. An ALC program may focus completely on a mature system. Identification of the basis of primary program activity accommodates these cases in addition to conventional phased programs. Nine differences were identified on this basis. Tables 41 and 42 present the competencies with response distribution differences.

Table 41. Frequency Differences Based On Primary Activity

Competency	Subgroup Median			
	Concepts	Technologies	Developmental Systems	Mature Systems
Be able to select an appropriate contract type for a project	Annually or Less	Annually or Less	Annually or Less	Quarterly
Understand contractor cost reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)	Quarterly	Monthly	Monthly	Quarterly
Be able to analyze contractor reports such as the CPR and CSSR	Quarterly	Quarterly	Monthly	Quarterly
Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action	Annually or Less	Quarterly	Monthly	Monthly

Three of the four competencies rejected based on frequency of use deal with cost controls and evaluating contractor performance. The median values reflect an increased frequency of evaluating contractor-recommended corrective actions as the system matures. The CPR and C/SSR competencies may also reflect an increasing trend with system maturity although the mature system medians drop back down. A potential

contributor to the decreased frequency of analysis and understanding of contractor cost and schedule reports is the fact that firm fixed price contracts, which are more common on production programs and commodity purchases, do not require cost and schedule reporting.

Table 42. Importance Differences Based on Primary Activity

Competency	Subgroup Median			
	Concepts	Technologies	Developmental Systems	Mature Systems
Understand the impact of production rate and quantity decisions on program cost	Extremely Important	Very Important	Extremely Important	Very Important
Understand the impact of budget cuts on unit marginal cost	Important	Very Important	Extremely Important	Very Important
Be able to select an appropriate contract type for a project	Very Important	Very Important	Extremely Important	Very Important
Understand congressional reporting requirements	Important	Important	Very Important	Very Important
Understand the impact of changes in scope on the cost of defense contracts	Important	Very Important	Extremely Important	Very Important

There appears to be an increased importance placed on several competencies during the developmental systems period. Since this is the time when key decisions involving production of the system are made, it seems logical that consideration of budget cuts, scope changes, and production contract types would be critical to the success of the program. A somewhat surprising result is the great importance those focusing on concepts placed on consideration of production rates and quantities. However, those doing concept studies for major programs may very well be called upon to weigh these issues in determining the budget required for the effort.

Position Certification Level

Ten differences were identified between the intermediate and senior level program managers. Tables 43 and 44 present these competencies and the subgroup median values. In comparing subgroup medians, it is important to note that the response distributions may be different even if the median values are identical.

Table 43. Frequency Differences Based On Position Level

Competency	Subgroup Median	
	Level II	Level III
Understand cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)	Quarterly	Monthly
Understand the products of cost management software tools	Quarterly	Monthly
Understand the utilization of EAC in cost management	Quarterly	Monthly
Understand contractor cost reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)	Monthly	Monthly
Be able to analyze contractor reports such as the CPR and CSSR	Quarterly	Monthly
Be able to evaluate contractor-recommended corrective actions and select an appropriate course of action	Monthly	Monthly
Be able to develop corrective actions to counter unfavorable program variances	Quarterly	Monthly

It appears that the Level II program managers are less frequently called upon to use many of the competencies in Table 43.

Table 44. Importance Differences Based On Position Level

Competency	Subgroup Median	
	Level II	Level III
Be able to apply learning curve techniques to analyze production costs	Important	Important
Understand the concept of earned value and methods for calculating it	Important	Very Important
Understand the utilization of EAC in cost management	Very Important	Very Important

An additional comparison between intermediate and senior level personnel was made by determining the number of application (be able to) and comprehension (understand) competencies valuable to each level. Figure 10 illustrates this comparison.

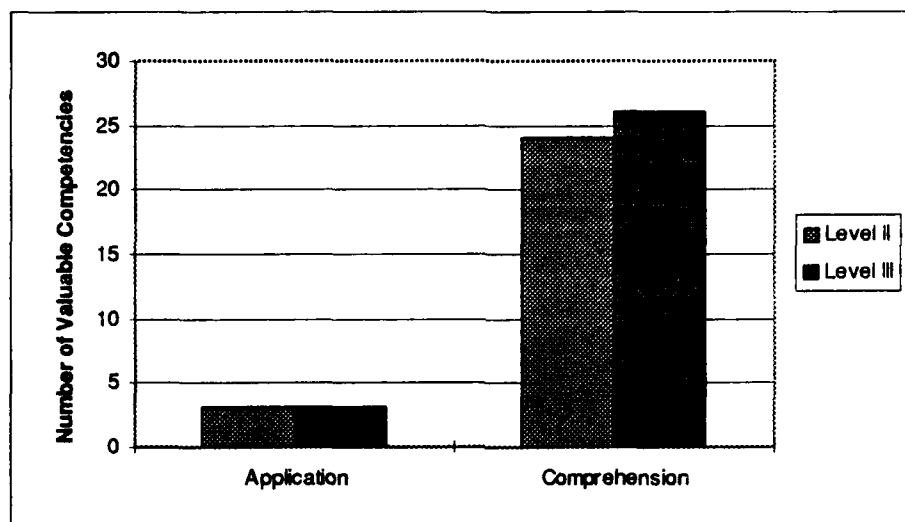


Figure 10. Application vs. Comprehension Competencies by Position Level

The data does not support a hypothesis that intermediate level program managers would be required to both comprehend and apply cost management competencies, while senior level managers would only be required to comprehend the results. In fact, both intermediate and senior level program managers value comprehension over application. Not only do intermediate and senior level program managers value a similar *number* of comprehension and application competencies, they value almost the *exact same* competencies. The only exception was that senior level managers valued two additional competencies:

- Understand the impact of the time value of money on financing and budgeting

- Understand the concept of earned value and methods for calculating it

The existence of program control and financial management staffs to support program managers may contribute to the tendency of both levels of program manager to favor comprehension over application by relieving them of the necessity to complete the analyses themselves.

Omitted Competencies

An open-ended question in the final section of the instrument asked if any important cost management competencies were omitted from the model. The responses varied from topic areas that were already covered in the original model, to new concepts that had not been considered. Some comments addressed topic areas from the original model, but at a different level of detail. Table 45 summarizes the topic areas in the responses.

Table 45. Open-Ended Response Topics

Topic Area	Frequency
Appropriations (type of funds, year of funds, expiring funds, unobligated funds, obligation and expenditure rates, etc.)	17
Legal & regulatory issues impacting cost management (Anti-Deficiency, Buy American, "Bonafide Need" rule, etc.)	10
Integrated Cost/Schedule/Requirements Management	6
Evaluating cost proposals for source selections and ECPs	5
POM inputs and exercises / PPBS process	4
Contract termination issues	4
Internal cost management (supplies, TDY, personnel, etc.)	3
Risk evaluation and management	3
Sustainment	3
Intergovernmental relationships and funds transfer (MIPRs, MORDs)	2
Handling cost overruns	2

Topic Area	Frequency
Impact of overhead costs and methods for calculating overhead rates	2
Activity Based Costing	1
Cost management issues in foreign military sales	1
Pricing	1
Cost management issues associated with GFP/GFE/GFI	1
Contractor cash flow	1
Development of a CPAR	1
Understand outcomes of contractor stockholder meetings	1
Teaming with the contractor	1
Logistics cost management	1
Stock fund issues	1
Industrial base issues and cost management	1
Relationship between EAC and year of funds	1
Expansion of contract type selection topic area	1
Selecting an appropriate cost estimating method	1
Analyze contractor work packages	1
Understand / evaluate contractor resource allocation systems	1
Lack of an accepted return-on-investment method or rate	1
Other government costs	1
Impact of politics on cost estimates	1
Cost Management Metrics	1
Negotiation	1
Understanding government systems for tracking and reporting commitments, obligations, and expenditures	1
Sensitivity analyses on cost estimates	1
Real-time cost management	1
Understand how contractor cost account managers work	1

The most commonly addressed area was appropriations. The comments dealt with several specific areas under the appropriations umbrella. There appears to be enough complexity in this area to justify expanding its coverage in the model. Several respondents noted important legal and regulatory issues not addressed in the original model including

the Anti-Deficiency and Buy American Acts. This area could be addressed in a future revision of the cost management model.

Conclusion

The data provided by the 330 respondents indicates that 29 of the 47 competencies in the model are considered valuable by military program managers in the field. Many topics in the model consisted of two competencies; one being the ability to complete the task and the other the ability to understand the results. In this case, 26 of the 29 valuable competencies were at the understanding level, indicating that program managers place little value on being able to complete these tasks themselves. The existence of support staff such as cost analysts and financial managers may contribute to this perception.

The number of response distribution differences identified in each biographic category varied. There was almost no variation on the basis of *management education*. Roughly 10% of the Kruskal-Wallis tests identified variations in the perceived importance or frequency of use of competencies on the basis of position certification level or primary program activity. In terms of organization type, there were no differences in the perceived importance of the competencies. However, 12 competencies showed differences in frequency of use. The respondents also produced a number of topic areas that should be considered for inclusion in future cost management competency models.

V. Conclusions and Recommendations

Introduction

Acquisition organizations have historically handled over 35 % of the DoD budget (Cheney, 1993:143). The sheer magnitude of money involved and the intense negative publicity resulting from failures in this area make cost management critically important to DoD program managers and senior staff. This research effort was conducted to evaluate the cost management competencies valued by Air Force program managers. The effort focused on two major research questions: What cost management competencies do program managers value, and how do these perceptions vary among subgroups of the population?

In order to answer these questions, a 47 element cost management competency model was developed from a foundation of management research and education programs. The key resources were the Project Management Institute's Project Management Body of Knowledge and a program management competency list developed by the Acquisition Management Functional Board. An important feature of the model was the consideration of the difference between the ability to complete a task and the ability to understand the results of an effort.

The perceptions of Air Force program managers were gathered through a mail survey regarding the perceived importance and frequency of use of the competencies in the model. The survey was distributed to 682 intermediate and senior level program managers in Air Force Materiel Command. A total of 330 managers responded. The

remainder of this chapter summarizes the study results and presents conclusions, recommendations, and suggestions for further study.

Results

A combined measure of frequency and importance indicated that 29 of the 47 competencies were valuable to program managers. Of these, 26 involved understanding, while only three involved having the ability to actually complete a task. The competency model contained three major areas: cost estimating and forecasting, cost budgeting, and cost control. The cost control section showed the highest proportion of valuable competencies, followed by the cost budgeting and cost estimating and forecasting sections.

Variations in responses were examined based on four factors: organization type, management education, primary program activity, and the certification level of the position. The number of response distribution differences identified in each biographic category varied. There was almost no variation on the basis of management education. There was variance in the frequency of use of one third of the competencies on the basis of organization type, but almost no variation in perceived importance on this basis. There was variation in the perceived importance and frequency of use of roughly 10 % of the competencies on the basis of primary program activity and position certification level.

Conclusions

The results of this research have direct implications for defense program managers. In particular, the results are relevant to the education and training of program managers, their classification in the acquisition workforce, and their professional certification.

Education and Training

Education and training programs consume time and money, both of which are limited resources. The goal of these programs should be to develop the competencies that will provide the most benefit to program managers on the job. Once the most important competencies have been identified, the best method to convey the information must be determined. Determining the optimum training method for the important competencies identified in this study would require further research as discussed below. In the meantime, there are opportunities to improve our current programs.

The results of this study indicate that program managers value comprehension level competencies over application level competencies. The existence of program control and financial management staffs could account for this response. The support staff completes the analysis and the program manager makes decisions based upon their results.

This recurrent theme was reflected in the comments of respondents:

A program manager shouldn't be doing these detail[ed] cost things, he should have experts doing them and advising him on what's happening. He should be schooled in these things so he understands what he is being told. If he is doing these detail[ed] things he is micro managing and not doing his primary job of managing his program to success!

I'm a colonel & while I don't personally do a lot of these things, folks that work for me do!

Within an IPT structure, I rely on the financial management members of the team to actually do the analysis. It is important for me to understand their analysis and its implications, but not important for me to be able to do it myself. I count on them to inform me of adverse trends.

The prevalence of understanding over doing was visible in the most frequently used, most important, and most valuable competencies. The trend carried through both intermediate and senior level program managers. The implication is that education and training programs should emphasize understanding. Instead of focusing on repeated execution of a given competency, programs might discuss and demonstrate the competency, but focus on understanding the implications of the results. The point is not that doing the task will not enhance understanding. Rather, it is a question of emphasis, placing less emphasis on the technique itself than on how the results might impact the actions of a program manager.

For example, the methods for calculating estimates at completion can be taught and demonstrated. The instruction might then be extended to include a discussion of the management decisions that the results might dictate. This approach expands the narrow topic to the bigger picture. An alternate approach is to incorporate some details in broader discussions. This points toward a case study or situational analysis approach. In this case, the discussion of a case might present actual estimate at completion values. The decisions made by the program managers and their impact on the program can then be analyzed.

Respondents mentioned the need to complete *what if* exercises with budgets and cost estimates. The results also showed that competencies dealing with the impact of

changes in scope and corrective actions were valuable to program managers. The common element was assessing the impact of changes in inputs, resources, rates, quantities, schedule, etc. This concept can be incorporated into education and training programs through question structure. Instead of providing a single, work-through question using the competency, follow the question up with some change questions. What is the impact of cutting delivery quantity in half on unit price? What is the schedule impact of a 30% cut in manpower? Which production method is optimum if the price of materials increases by 20%?

The results also point out some areas that may receive relatively less emphasis in many education and training programs. The competency most frequently used by the program managers surveyed was understanding the impact of the political process on acquisition management. The results also highlighted the value of understanding the PPBS and congressional budgeting and appropriations processes. These processes are clearly subject to political influence, which only serves to enhance the value of improving the competency of program managers in operating in the political environment. The tenuous nature of operating in the political environment makes it difficult to convey in a conventional, textbook approach, and this may result in a decreased emphasis on this area in training. However, the importance of competence in this area is clear, and the subject may well be suited to the case study or situational analysis methods of instruction. Thamhain shows that experiential learning and observation account for 84% of project managers professional development (1991: 41). Developing competence operating in the political environment is probably particularly suited to these two methods.

Classification of Program Managers

Under APDP and DODD 5000.2, program managers are a distinct group of professionals in the acquisition workforce, but only one of many. The most common place people envision program managers is in a program office, and the data reflected this. However, there are a number of program management positions outside of the SPOs. One person who declined to complete the survey wrote:

I am unable to respond to your questionnaire [sic]. The duties of this office involve the day to day administration of the product center. This office is not doing product/program management. Although I have a program management background, my current position tasks do not lend themselves to what is asked in your questionnaire [sic].

Other similar responses raise the question of whether the variety of jobs currently covered under the program management umbrella are similar enough to be included in a single group. For the most part, this study supports the conclusion that they are, in terms of cost management. One could theorize that the cost management activities required of different organization types and program activities would vary, but there were few significant differences in the responses from these groups. The largest discrepancy was the difference in the frequency of use of 15 competencies among the various organization types. However, the program office was clearly the dominant organization type and in the coming era of cradle-to-grave management in the SPO, the distinction between some of the organization types may blur. Looking at the big picture, the differences identified in this study do not justify the additional administrative burden of managing program managers at a lower level.

Certification Programs

Program managers are currently certified under two sets of criteria. Under APDP, they are certified at one of three levels according to their experience, education, and training. Program management positions are also coded with the certification level desired of the person filling that job. A similar set of criteria is used to identify program managers as eligible for the acquisition corps. Those actually serving in positions identified as critical acquisition positions are considered members of the corps.

The presumption is that those meeting the criteria for certification are qualified for all positions at that level. Unfortunately, the criteria are quite general. No specific criteria exist for individual skill areas such as cost management. Even if validated competency models existed, the administrative burden of tracking to this level of detail and the difficulty of evaluating competence preclude the use of more specific criteria. Despite the desire to develop a certification system identifying program managers as qualified for a broad variety of jobs, it appears that individual qualifications and experience will, and should, continue to play a substantial role in the selection of officers for specific positions. Input from the gaining unit should thus be an important contribution to the Military Personnel Center's selection decision.

Recommendations

The results of this study have direct implications for the education and training of defense program managers. In order to maximize the benefit received for the time and money expended in education and training programs, these programs should be focused on the competencies that will prove most valuable to program managers in their jobs. The 29

valuable competencies identified in this effort can serve as a foundation for these decisions. The list might be expanded to account for the subjective nature of the decision rule used to identify the valuable competencies. Respondents identified several additional areas not included in the original model that could be evaluated through further research.

The results also indicate that program managers value understanding over the ability to complete a particular task. Education and training programs should therefore emphasize understanding the implications of cost management activities over rote memorization and repeated execution of a particular task. This can be accomplished by expanding the discussion of the topic after teaching and demonstrating a technique. The case study method is another excellent method for addressing the impact of cost analysis on program management decisions.

The existence of cost analysts and financial managers to support the program manager appeared to play a critical role in shaping the perceptions of program managers. The ability of support staffs to complete analyses leaves the program manager free to consider the implications of the results. Further research is warranted to clarify the relationships between these support personnel and the program manager.

Another important program management task is assessing the impact of program changes. Program managers are frequently called upon to assess the impact of changes in the funding, schedule, and scope of their programs. Education and training programs could incorporate consideration of changes into their question structure. Instead of requiring only a rote solution to a fixed problem, include additional questions regarding the impact of changing the inputs to the process or the desired output.

This results of this study do not appear to point toward any major changes in classification and certification programs. The number of differences in perceptions identified within the program management field do not appear to justify more detailed classification. While this study could lead to improved education and training programs, it does not indicate that changes are necessary in certification programs such as APDP. The administrative burden of tracking the competence of program managers in detailed cost management areas does not appear justified given the difficulty and subjectivity involved in evaluating competence.

Follow-On Research

There are many opportunities for continuing this research. These opportunities vary in scope and potential significance. The opportunities include modification and re-evaluation of the model, expanding the research to a broader population, extending the research to other functional areas, and increasing the depth of the research by considering level of competency and training.

Modifying the Model

The open-ended responses of the program managers provided valuable input on the scope and content of the competency model. The difficulty is developing a model that covers the important aspects of cost management without being so cumbersome that it is difficult to validate and difficult to use as a tool for structuring education and training programs. One possible research effort would integrate comments from the respondents

in this effort into a revised model. The revised model could then be evaluated by a similar group of program managers.

Determining the appropriate level of indenture for each competency is a problem in developing models of this type. Less important topics can be covered at a high level while more important and more complex topics should be covered in more detail. This problem was identified in at least one area of this study. A number of comments dealt with portions of the appropriations process. In particular, managers noted the importance of items such as obligation and expenditure rates, unobligated funds, expiring funds, type of money and year of money. The competency in the model dealing directly with the congressional budgeting and appropriations process could be expanded to reflect some of the particularly important elements individually.

There were several comments regarding the importance of integrating the management of cost, schedule, and requirements. This area includes such concepts as an integrated master schedule, design-to-cost, and relating technical and schedule requirements to dollar amounts. Although these concepts are fairly high level in the cost management functional area, they are probably worthy of mention in at least a single, general competency.

Although the model contained a competency dealing with understanding the organization's role in the PPBS process, several respondents commented on the POM process. The competency statement could be rewritten to more clearly reflect that the POM inputs are an organization's major contribution to the PPBS process.

Several topic areas that were not included in the original model may be worthy of inclusion in a cost management model. The importance of legal and regulatory issues such as anti-deficiency were noted in several responses. The original model did not discuss relationships and transfers of funds between government organizations. Other significant areas included activity based costing, contract termination issues, foreign military sales, government furnished property or information, and pricing issues.

Another issue is the management of costs within the organization such as travel, supplies, and support personnel. As one respondent noted:

what labs need (and other organization[s]) are the tools and capabilities to do cost accounting & management the same way we demand of contractors. How much does it cost to build something in a Lab, where do the dollars go, how are the schedules measured & maintained? There is no capability or commitment to execute in this manner but with falling budgets, we must get more efficient.

This area is probably neglected in most education and training program in favor of emphasis on SPO requirements. This area is probably worthy of inclusion in a model.

Broader Population

This research focused on military program managers within Air Force Materiel Command. The basic structure of this effort could be duplicated with a broader population of program managers including civilian program managers or other military services. Although civilian and military program managers work together on a daily basis, they often have different backgrounds and job experience. Military program managers are likely to have a broader variety of experience, while civilians may have more depth. It is therefore possible that military and civilian program managers value different cost

management competencies. Identifying differences between the two groups could highlight strengths and weaknesses resulting from their backgrounds and training. There is potential for improved education and training that more specifically targets the needs of each group.

The same argument supports studying other military services. Despite tight budgets and an emphasis on joint programs, each service maintains its own system for managing program costs and for educating and training its program managers. Programs such as DSMC's Program Management Course may provide some commonality, but program managers are a product of their upbringing. Having a common understanding of which cost management competencies are valuable to program managers would allow all the military services to focus their education and training programs on these areas. This more efficient approach to training could improve the performance of program managers on both single service and joint programs.

Cost Analysts and Financial Managers

The results of this effort reflect that program managers value comprehension of the competencies over their application. Many respondents cited the fact that the analyses and estimates in question are completed by support staffs and that program managers must simply understand the question. A potential research effort would be to evaluate the perceived importance and frequency of use of the competencies by the cost analysts and financial managers.

This effort could be based on the model and instruments developed in this study although the modifications described above could be incorporated. The proposed effort

would identify whether the cost analysts and financial managers complete the analyses attributed to them by the program manager or if the results come from contractor reports. The effort could also identify differences in the perceived value of various competencies among program managers, cost analysts, and financial managers. The study could also examine differences based on the structure of the organization. The roles of cost analysts, financial managers, and program managers may vary depending upon whether the structure is purely functional, matrix, or integrated product teams. The results could highlight limitations in the education and training of program managers and could result in better coordination between these functional support areas and the program manager.

Other Skill Areas

The Project Management Institute's Project Management Body of Knowledge and the Defense Body of Knowledge derived by Best and Kobylarz divide program management into a number of skill areas of which cost management is only one. A similar research effort, involving development and evaluation of a competency model, could be conducted in a number of other skill areas. Skill areas that appear suited to study include quality management, logistics management, engineering management, manufacturing management, schedule management, and software management to name a few.

Competency and Training

This study evaluated the perceived importance and frequency of use of a set of cost management competencies in order to identify those valuable to program managers. A significant area not addressed by this study is the actual level of competency possessed

by program managers in each area. Program managers may not value a given competency because they do not understand its application or benefits. Thus, while education and training programs might be improved based on this research, the picture is incomplete without further study.

A related question is the training method. There are a number of questions in this area. The first is: Which of the wide variety of available sources, from on-the-job training to formal education, did program managers use to develop the competency?. Although the manager may have learned it through one method, it is also important to ask how they feel the competency should be acquired. There may be a better way to get the job done.

Addressing these issues for the complete competency model would require a significant amount of time from each respondent. An alternative approach is to select a subset of the competencies for analysis. Selection could be based on criteria such as the most important or frequently used competencies, the most valuable competencies (by the combined measure), or through a sample from each major category of the model (cost estimating and forecasting, cost budgeting, and cost control).

A final question involves identifying when specific competencies are required in a program manager's career. The tasks and knowledge required of program managers can vary as their careers progress. These questions could be answered by surveying program managers with significant experience. The perceptions of program managers in the field would form a basis for identifying the valuable competencies, the appropriate career point for development, and the optimum training method. A potential limitation of this

approach is that the perceptions of current program managers are a product of their training and experience, so they may be biased toward elements of the current system.

Appendix A: Survey Instruments

USAF SCN: 94-15



DEPARTMENT OF THE AIR FORCE
WASHINGTON DC



OFFICE OF THE ASSISTANT SECRETARY

11 MAY 1994

MEMORANDUM FOR SURVEY RESPONDENTS

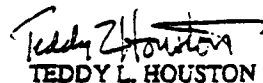
FROM: AFPEO/CM
1060 Air Force Pentagon
Washington DC 20330-1060

SUBJECT: Program Manager Cost Management Survey Package - ACTION MEMORANDUM

Effective cost management is crucial to the success of DoD acquisition programs. It is therefore important to determine which cost management practices are linked to effective program management. You were selected to participate in this research based on your experience, education, and training in the area of DoD program management. Your participation will greatly facilitate our efforts to influence the training and education of program managers.

This is not a test, and there are no right or wrong answers. It is important that you respond to each statement as thoughtfully and frankly as possible. Pretest of this survey indicates that it will take you approximately 11 minutes to complete it.

Participation in this research is voluntary, but your contribution is important and will be used as an input to improve training and education programs. No effort will be made to associate you with your response. Nonparticipation will not result in any adverse action. Please return this survey package no later than 1 May 1994 to the address indicated on the survey package. For further information, contact Capt Brent Baxter at AFIT/LA, DSN 785-7777, ext. 2109.


TEDDY L. HOUSTON

Associate Director of Acquisition
Career Management
Assistant Secretary (Acquisition)

3 Attachments:

1. Survey
2. AFIT form IIC
3. Return Envelope

Program Manager Cost Management Survey

Instructions:

- Use a number 2 pencil
- Please read each question and darken the appropriate circle on the answer sheet provided
- Space for written comments has been provided at the end of the survey
- Your responses will remain anonymous. Please do not put your name on the answer sheet
- Thank you for your time
- If you have any questions please contact Capt Brent Baxter at:
DSN: 785-7777 x2109
Commercial: (513) 255-7777 x2109

Section 1: Biographical Questions

1. Which of the following advanced management education programs have you completed?
 - A. None
 - B. Graduate Management Degree
 - C. Defense Systems Management College (Program Management Course)
 - D. Both B and C

2. In what type of organization do you work?
 - A. System Program Office
 - B. Laboratory
 - C. Headquarters
 - D. Air Logistics Center
 - E. Other _____.

3. With which do you generally work?
 - A. Concepts (Basic Research, Concept Exploration)
 - B. Technologies (Technology Development, Demonstration/Validation)
 - C. Developmental Systems (Engineering and Manufacturing Development)
 - D. Mature Systems (Production, Deployment, and Support)

Please Turn to the Next Page

Section 2: Importance

In this section you will evaluate program manager competencies in terms of *importance*. Please note the response scale when answering the questions.

Importance					
1	2	3	4	5	6
Not Important	Slightly Important	Important	Very Important	Extremely Important	Don't Know

How important is it for you to:

4. *Understand* current economic conditions and their impact on defense contractors
5. *Be able to* evaluate contractor financial health and viability using financial statements
6. *Understand* the results of financial statement analysis conducted to evaluate contractor financial health
7. *Be able to* apply time value of money techniques such as return on investment (ROI), net present value (NPV), internal rate of return (IRR), and Discounted Cash Flow (DCF)
8. *Understand* the impact of the time value of money on financing and budgeting
9. *Understand* how contractors secure funds to support ongoing projects, plant improvements, and new product development
10. *Be able to* develop a cost estimate using appropriate methods (e.g. parametric, analogy, grass roots)
11. *Understand* cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)
12. *Be able to* use statistical analysis methods such as range analysis and confidence intervals to characterize the uncertainty associated with cost estimates
13. *Understand* the implications of uncertainty associated with cost estimates
14. *Be able to* use software tools to support cost estimation, cost analysis, and presentation
15. *Understand* the products of cost management software tools
16. *Understand* how contractors apply management reserve to respond to contingencies over the duration of a contract
17. *Be able to* apply inflation factors to program costs and funding
18. *Understand* the impact of inflation on program costs and funding
19. *Understand* the impact of production rate and quantity decisions on program cost
20. *Understand* the impact of budget cuts on unit marginal cost
21. *Understand* cost elements such as direct labor, direct materials, general & administrative, profit, and overhead
22. *Understand* ways to characterize costs such as fixed/variable and recurring/non-recurring
23. *Be able to* do break-even analysis using the concepts of fixed and variable costs
24. *Understand* the cost concepts of reasonableness, allocability, and allowability
25. *Be able to* apply learning curve techniques to analyze production costs

Importance

1	2	3	4	5	6
Not Important	Slightly Important	Important	Very Important	Extremely Important	Don't Know

How important is it for you to:

26. *Understand* the impact of learning curves on production costs
27. *Understand* the impact of the time value of money on financing and budgeting
28. *Be able to* develop a Work Breakdown Structure (WBS) that describes the entire work effort
29. *Understand* the uses of a WBS for cost management
30. *Understand* the role the organization plays in the Planning, Programming, and Budgeting System (PPBS)
31. *Understand* the congressional budgeting and appropriations processes
32. *Understand* the flow of funds through the expenditure categories of commitments, obligations, and expenditures
33. *Be able to* distribute the cost of work packages across the time horizon to develop a performance measurement baseline (PMB)
34. *Understand* the composition of a PMB
35. *Be able to* evaluate contractor cost accounting and control systems
36. *Understand* contractor cost accounting and control systems
37. *Be able to* select the appropriate contract type for a project
38. *Understand* the cost implications of alternative contract types and pricing mechanisms
39. *Understand* the impact of the political environment on acquisition management
40. *Be able to* generate congressionally required reports such as the Selected Acquisition Report (SAR)
41. *Understand* congressional reporting requirements
42. *Understand* the legal and regulatory requirements for cost and schedule control systems such as C/SCSC
43. *Understand* the impact of changes in scope on the cost of defense contracts
44. *Be able to* estimate earned value using methods such as weighted milestones and percent complete
45. *Understand* the concept of earned value and methods for calculating it
46. *Be able to* develop an estimate at completion (EAC) based on the data presented in contractor performance reports
47. *Understand* the use of estimates at completion (EAC) in cost management
48. *Be able to* analyze contractor reports such as the CPR and CSSR
49. *Understand* contractor cost reports such as the Cost Performance Report (CPR) and Cost / Schedule Status Report (CSSR)
50. *Be able to* evaluate contractor-recommended corrective actions and select an appropriate course of action
51. *Be able to* develop corrective actions to counter unfavorable program variances

Section 3: Frequency

In this section you will evaluate program manager competencies in terms of *frequency of use*. Please note the new response scale.

Frequency					
1	2	3	4	5	6
Annually or less	Quarterly	Monthly	Weekly	Daily	Don't Know

How frequently are you called upon to:

52. *Apply* time value of money techniques such as return on investment (ROI), net present value (NPV), internal rate of return (IRR), and Declining Cash Flow (DCF)

53. *Understand* the impact of the time value of money on financing and budgeting

54. *Understand* how contractors secure funds to support ongoing projects, plant improvements, and new product development

55. *Develop* a cost estimate using appropriate methods (e.g. parametric, analogy, grass roots)

56. *Understand* cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)

Comments

- Do you feel that any significant program manager cost management competencies were omitted?
- What single activity related to cost management is the most important to you and what activity is most frequently used?
- Any other comments?

Program Manager Cost Management Survey

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55. *Be able to* develop a cost estimate using appropriate methods (e.g. parametric, analogy, grass roots)

56. *Understand* cost estimates developed using appropriate methods (e.g. parametric, analogy, grass roots)

Comments

- Do you feel that any significant program manager cost management competencies were omitted?
- What single activity related to cost management is the most important to you and what activity is most frequently used?
- Any other comments?

Appendix B: Response Summary

Frequency

Competency	Median	% 4 or 5		Competency	Median	% 4 or 5
1.1	3	35.1		2.1	1	1.9
1.2	1	4.5		2.2	3	16.9
1.3	1	6.9		2.3	3	37.8
1.4	1	2.0		2.4	3	35.0
1.5	2	18.5		2.5	3	45.9
1.6	1	8.4		2.6	1	3.4
1.7	2	5.8		2.7	2	11.1
1.8	2	15.0		2.8	1	2.6
1.9	1	0.0		2.9	2	9.6
1.10	3	22.0		2.10	1	5.7
1.11	1	9.3		2.11	2	16.0
1.12	2	19.5		2.12	3	46.2
1.13	3	14.0		2.13	1	2.0
1.14	2	13.5		2.14	2	16.5
1.15	2	25.4		3.1	2	10.4
1.16	2	23.7		3.2	3	42.3
1.17	2	24.9		3.3	2	12.7
1.18	3	27.8		3.4	1	8.6
1.19	3	27.6		3.5	1	5.7
1.20	1	3.4		3.6	3	14.4
1.21	2	19.1		3.7	3	11.4
1.22	1	2.0		3.8	3	3.8
1.23	2	12.1		3.9	3	28.1
				3.10	2	18.3

Importance

Competency	Median	% 4 or 5		Competency	Median	% 4 or 5
1.1	4	57.1		2.1	3	40.4
1.2	3	44.7		2.2	4	73.8
1.3	4	63.1		2.3	5	80.9
1.4	2	22.2		2.4	4	73.2
1.5	3	46.1		2.5	4	78.5
1.6	3	33.9		2.6	3	28.2
1.7	3	42.8		2.7	4	60.2
1.8	5	79.6		2.8	3	34.8
1.9	3	25.9		2.9	4	59.9
1.10	4	70.2		2.10	4	70.3
1.11	2	22.0		2.11	4	81.5
1.12	4	59.5		2.12	4	64.9
1.13	4	60.2		2.13	3	45.0
1.14	3	32.1		2.14	4	62.8
1.15	4	65.5		3.1	4	50.3
1.16	4	79.6		3.2	4	81.5
1.17	4	72.3		3.3	4	54.3
1.18	4	75.6		3.4	3	24.3
1.19	4	70.3		3.5	3	32.4
1.20	3	28.5		3.6	4	71.8
1.21	4	55.1		3.7	4	73.9
1.22	3	25.8		3.8	4	51.2
1.23	4	60.4		3.9	5	85.1
				3.10	5	79.8

Appendix C: Ranked Data

Frequency

Competency	% 4 or 5		Competency	% 4 or 5		Competency	% 4 or 5
2.12	46.2		3.10	18.3		1.6	8.4
2.5	45.9		2.2	16.9		1.3	6.9
3.2	42.3		2.14	16.5		1.7	5.8
2.3	37.8		2.11	16.0		2.10	5.7
1.1	35.1		1.8	15.0		3.5	5.7
2.4	35.0		3.6	14.4		1.2	4.5
3.9	28.1		1.13	14.0		3.8	3.8
1.18	27.8		1.14	13.5		1.20	3.4
1.19	27.6		3.3	12.7		2.6	3.4
1.15	25.4		1.23	12.1		2.8	2.6
1.17	24.9		3.7	11.4		1.4	2.0
1.16	23.7		2.7	11.1		1.22	2.0
1.10	22.0		3.1	10.4		2.13	2.0
1.12	19.5		2.9	9.6		2.1	1.9
1.21	19.1		1.11	9.3		1.9	0
1.5	18.5		3.4	8.6			

Importance

Competency	% 4 or 5		Competency	% 4 or 5		Competency	% 4 or 5
3.9	85.1		1.10	70.2		2.13	45.0
2.11	81.5		1.15	65.5		1.2	44.7
3.2	81.5		2.12	64.9		1.7	42.6
2.3	80.9		1.3	63.1		2.1	40.4
3.10	79.8		2.14	62.8		2.8	34.8
1.8	79.6		1.23	60.4		1.6	33.9
1.16	79.6		1.13	60.2		3.5	32.4
2.5	78.5		2.7	60.2		1.14	32.1
1.18	75.6		2.9	59.9		1.20	28.5
3.7	73.9		1.12	59.5		2.6	28.2
2.2	73.8		1.1	57.1		1.9	25.9
2.4	73.2		1.21	55.1		1.22	25.8
1.17	72.3		3.3	54.3		3.4	24.3
3.6	71.8		3.8	51.2		1.4	22.2
1.19	70.3		3.1	50.3		1.11	22.0
2.10	70.3		1.5	46.1			

Appendix D: Decision Rule Application to Total Sample

Competency	Median Sum	Valuable		Competency	Median	Valuable
1.1	7	X		2.1	4	
1.2	4			2.2	7	X
1.3	5			2.3	8	X
1.4	3			2.4	7	X
1.5	5			2.5	7	X
1.6	4			2.6	4	
1.7	5			2.7	6	X
1.8	7	X		2.8	4	
1.9	4			2.9	6	X
1.10	7	X		2.10	5	
1.11	3			2.11	6	X
1.12	6	X		2.12	7	X
1.13	7	X		2.13	4	
1.14	5			2.14	6	X
1.15	6	X		3.1	6	X
1.16	6	X		3.2	7	X
1.17	6	X		3.3	6	X
1.18	7	X		3.4	4	
1.19	7	X		3.5	4	
1.20	4			3.6	7	X
1.21	6	X		3.7	7	X
1.22	4			3.8	7	X
1.23	6	X		3.9	8	X
				3.10	7	X

Appendix E: Don't Know Percentages

Frequency Don't Know Percent

Competency	% Don't Know		Competency	% Don't Know		Competency	% Don't Know
1.1	1.2		1.17	0.6		2.10	1.9
1.2	2.5		1.18	0		2.11	3.7
1.3	1.9		1.19	1.9		2.12	1.9
1.4	5.6		1.20	8.1		2.13	8.1
1.5	2.5		1.21	6.2		2.14	6.2
1.6	3.1		1.22	5.6		3.1	5.6
1.7	4.3		1.23	3.1		3.2	3.7
1.8	1.9		2.1	3.1		3.3	3.1
1.9	6.2		2.2	1.2		3.4	6.2
1.10	1.9		2.3	1.9		3.5	1.9
1.11	6.8		2.4	1.2		3.6	1.2
1.12	4.3		2.5	1.9		3.7	2.5
1.13	3.1		2.6	8.7		3.8	1.2
1.14	3.7		2.7	6.2		3.9	0.6
1.15	0.6		2.8	5.6		3.10	1.2
1.16	1.2		2.9	3.7			

Importance Don't Know Percent

Competency	% Don't Know		Competency	% Don't Know		Competency	% Don't Know
1.1	0		1.17	0		2.10	0
1.2	0		1.18	0		2.11	0
1.3	0		1.19	0		2.12	0
1.4	0.6		1.20	0		2.13	0
1.5	0.6		1.21	0		2.14	0
1.6	0		1.22	0		3.1	0
1.7	0.6		1.23	0		3.2	0
1.8	0.6		2.1	0		3.3	0
1.9	1.2		2.2	0		3.4	0
1.10	0		2.3	0		3.5	0
1.11	0		2.4	0		3.6	0
1.12	0.6		2.5	0		3.7	0
1.13	0		2.6	0		3.8	0
1.14	0		2.7	0		3.9	0
1.15	0		2.8	0		3.10	0
1.16	0		2.9	0			

Appendix F: Kruskal-Wallis Results

Management Education

Competency	Importance P-Value	Frequency P-Value		Competency	Importance P-Value	Frequency P-Value
1.1	.8137	.6806		2.1	.6143	.3589
1.2	.8777	.8653		2.2	.8207	.7369
1.3	.9334	.8409		2.3	.2926	.1335
1.4	.1817	.2481		2.4	.5357	.1022
1.5	.6922	.8823		2.5	.8601	.1536
1.6	.1684	.8350		2.6	.5479	.5202
1.7	.7550	.6906		2.7	.6040	.0595
1.8	.4016	.0418		2.8	.7557	.6569
1.9	.8712	.3492		2.9	.7731	.9404
1.10	.9106	.1294		2.10	.1477	.1953
1.11	.4163	.3364		2.11	.3258	.1077
1.12	.4103	.4593		2.12	.9418	.0843
1.13	.8538	.4097		2.13	.1234	.6243
1.14	.8721	.4104		2.14	.3532	.8556
1.15	.3394	.8519		3.1	.7086	.3483
1.16	.3545	.8791		3.2	.9214	.3486
1.17	.1280	.2892		3.3	.2548	.0938
1.18	.5879	.0761		3.4	.2590	.8256
1.19	.4105	.3986		3.5	.4218	.9879
1.20	.4979	.8460		3.6	.6626	.6214
1.21	.3166	.1915		3.7	.2544	.4238
1.22	.4237	.9391		3.8	.6225	.5461
1.23	.0192	.7547		3.9	.9590	.6222
				3.10	.8193	.1616

Organization Type

Competency	Importance P-Value	Frequency P-Value		Competency	Importance P-Value	Frequency P-Value
1.1	.3028	.0189		2.1	.1189	.8170
1.2	.2543	.5881		2.2	.9539	.1940
1.3	.6534	.9117		2.3	.8439	.1911
1.4	.9378	.0477		2.4	.4573	.0645
1.5	.9616	.3205		2.5	.5781	.0604
1.6	.3190	.3210		2.6	.1988	.6920
1.7	.2618	.5466		2.7	.3779	.9526
1.8	.3247	.7802		2.8	.9499	.8609
1.9	.2542	.5054		2.9	.6400	.5375
1.10	.8798	.0968		2.10	.2790	.0053
1.11	.1782	.7945		2.11	.3810	.0525
1.12	.6884	.7502		2.12	.1206	.5525
1.13	.7078	.1538		2.13	.5210	.1180
1.14	.4235	.0688		2.14	.5792	.1697
1.15	.5204	.0463		3.1	.5496	.9482
1.16	.5859	.0309		3.2	.3418	.5013
1.17	.7494	.0818		3.3	.9240	.3169
1.18	.5478	.0131		3.4	.9870	.4726
1.19	.9027	.0236		3.5	.8797	.4002
1.20	.1803	.3227		3.6	.2520	.0499
1.21	.7991	.9355		3.7	.7029	.0108
1.22	.8847	.0481		3.8	.6909	.0005
1.23	.6866	.1143		3.9	.5361	.0042
				3.10	.8421	.1206

Primary Program Activity

Competency	Importance P-Value	Frequency P-Value	Competency	Importance P-Value	Frequency P-Value
1.1	.8173	.3319	2.1	.9542	.1426
1.2	.5404	.5418	2.2	.2401	.1661
1.3	.6946	.8972	2.3	.2856	.3502
1.4	.9892	.1988	2.4	.6014	.4427
1.5	.4867	.3958	2.5	.6728	.1220
1.6	.6419	.5655	2.6	.7441	.5388
1.7	.6191	.9233	2.7	.1020	.8704
1.8	.4642	.8464	2.8	.9935	.6625
1.9	.3681	.9737	2.9	.0730	.7983
1.10	.5214	.2059	2.10	.0152	.0119
1.11	.5596	.2157	2.11	.0506	.2338
1.12	.0575	.9259	2.12	.3216	.8915
1.13	.2567	.2798	2.13	.7447	.2734
1.14	.4321	.5584	2.14	.0132	.5185
1.15	.6779	.7904	3.1	.1595	.4435
1.16	.0341	.0599	3.2	.0124	.7189
1.17	.0029	.5248	3.3	.0573	.1826
1.18	.1873	.2612	3.4	.4950	.2718
1.19	.4353	.0977	3.5	.7385	.0544
1.20	.3733	.6931	3.6	.0517	.1701
1.21	.7993	.1145	3.7	.0758	.0435
1.22	.4509	.6471	3.8	.3186	.0062
1.23	.3407	.6386	3.9	.2833	.0112
			3.10	.2959	.0794

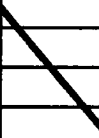
Position Certification Level

Competency	Importance P-Value	Frequency P-Value		Competency	Importance P-Value	Frequency P-Value
1.1	.2788	.0932		2.1	.0728	.5908
1.2	.1176	.7593		2.2	.4160	.1768
1.3	.4323	.4250		2.3	.4584	.3722
1.4	.7003	.3011		2.4	.2265	.1116
1.5	.2590	.1525		2.5	.3397	.1589
1.6	.1285	.3230		2.6	.6358	.2271
1.7	.2330	.7035		2.7	.2648	.0586
1.8	.4503	.0407		2.8	.9452	.6920
1.9	.4055	.2389		2.9	.5353	.8166
1.10	.1711	.4324		2.10	.7318	.4863
1.11	.1505	.5424		2.11	.7339	.3254
1.12	.4040	.0224		2.12	.4836	.7371
1.13	.1282	.5868		2.13	.1532	.5833
1.14	.0952	.0790		2.14	.4400	.2056
1.15	.2723	.2806		3.1	.1550	.1167
1.16	.5470	.6104		3.2	.8653	.3945
1.17	.1016	.7869		3.3	.0087	.1768
1.18	.4217	.6433		3.4	.3577	.1935
1.19	.9809	.8799		3.5	.9768	.2410
1.20	.6683	.1311		3.6	.0462	.0110
1.21	.1897	.3358		3.7	.1617	.0113
1.22	.0306	.1470		3.8	.7817	.0183
1.23	.2519	.3725		3.9	.4822	.0299
				3.10	.5357	.0343

Appendix G: Competency Ranking for Group Comparison

Frequency

Competency	% 4 or 5		Competency	% 4 or 5 with Alternate Data
2.12	46.2		2.12	46.2
2.5	45.9		2.5	45.9
3.2	42.3		3.2	42.3
2.3	37.8		2.3	37.8
1.1	35.1		1.1	35.1
2.4	35		2.4	35
3.9	28.1		3.9	28.1
1.18	27.8		1.18	27.8
1.19	27.6		1.19	27.6
1.15	25.4		1.15	25.4
1.17	24.9		1.17	24.9
1.16	23.7		1.8	24.6
1.101	22		1.16	23.7
1.12	19.5		1.101	22
1.21	19.1		1.12	19.5
1.5	18.5		1.21	19.1
3.101	18.3		3.101	18.3
2.2	16.9		1.5	17.1
2.14	16.5		2.2	16.9
2.11	16		2.14	16.5
1.8	15		2.11	16
3.6	14.4		3.6	14.4
1.13	14		1.13	14
1.14	13.5		1.14	13.5
3.3	12.7		3.3	12.7
1.23	12.1		1.23	12.1
3.7	11.4		3.7	11.4
2.7	11.1		2.7	11.1
3.1	10.4		3.1	10.4
2.9	9.6		2.9	9.6
1.11	9.3		1.11	9.3
3.4	8.6		1.6	9.2
1.6	8.4		3.4	8.6

Competency	% 4 or 5		Competency	% 4 or 5 with Alternate Data
1.3	6.9		1.3	6.9
1.7	5.8	<hr/>	1.7	6.6
2.101	5.7		2.101	5.7
3.5	5.7		3.5	5.7
1.2	4.5		1.2	4.5
3.8	3.8		3.8	3.8
1.201	3.4		1.201	3.4
2.6	3.4		2.6	3.4
2.8	2.6		2.8	2.6
1.4	2		1.22	2
1.22	2		2.13	2
2.13	2		2.1	1.9
2.1	1.9		1.4	1.2
1.9	0		1.9	0

Importance

Competency	% 4 or 5		Competency	%4 or 5 With Alternate Data
3.9	85.1		3.9	85.1
2.11	81.5		2.11	81.5
3.2	81.5		3.2	81.5
2.3	80.9		2.3	80.9
3.101	79.8		3.101	79.8
1.8	79.6		1.16	79.6
1.16	79.6		2.5	78.5
2.5	78.5		1.18	75.6
1.18	75.6		3.7	73.9
3.7	73.9		2.2	73.8
2.2	73.8		2.4	73.2
2.4	73.2		1.17	72.3
1.17	72.3		3.6	71.8
3.6	71.8		1.19	70.3
1.19	70.3		2.101	70.3
2.101	70.3		1.101	70.2
1.101	70.2		1.15	65.5
1.15	65.5		2.12	64.9
2.12	64.9		1.8	64.4
1.3	63.1		1.3	63.1
2.14	62.8		2.14	62.8
1.23	60.4		1.23	60.4
1.13	60.2		1.13	60.2
2.7	60.2		2.7	60.2
2.9	59.9		2.9	59.9
1.12	59.5		1.12	59.5
1.1	57.1		1.1	57.1
1.21	55.1		1.21	55.1
3.3	54.3		3.3	54.3
3.8	51.2		3.8	51.2
3.1	50.3		3.1	50.3
1.5	46.1		2.13	45
2.13	45		1.2	44.7
1.2	44.7		1.5	40.9

Competency	% 4 or 5		Competency	% 4 or 5 with Alternate Data
1.7	42.6		2.1	40.4
2.1	40.4		2.8	34.8
2.8	34.8		1.7	33
1.6	33.9		3.5	32.4
3.5	32.4		1.14	32.1
1.14	32.1		1.6	31.2
1.201	28.5		1.201	28.5
2.6	28.2		2.6	28.2
1.9	25.9		1.9	25.9
1.22	25.8		1.22	25.8
3.4	24.3		3.4	24.3
1.4	22.2		1.11	22
1.11	22		1.4	16.5

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13. ABSTRACT (Maximum 200 words) The magnitude of money involved in the acquisition of defense systems and the public scrutiny resulting from cost overruns and program failures make cost management competence critical to program success. This research examined the cost management competencies required of defense program managers. A cost management competency model was developed from a foundation of past research. The model was evaluated through a mail survey of 682 intermediate and senior level military program managers in Air Force Materiel Command. The results provided by the 330 respondents indicate that 29 of the 47 competencies in the model were valuable to the program managers. The results indicate that both intermediate and senior level program managers rely more on understanding cost management concepts than on being able to complete the tasks themselves. Data analysis identified differences in the perceived importance and frequency of use of some competencies based on management education, organization type, primary program activity, and position certification level. The results have direct implications for the development of defense program managers. Education and training programs can be improved by focusing on the cost management competencies that will be most valuable to program managers in the field.				
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